VOLUME XXXVII NO. 195 NOVEMBER-DECEMBER 1952

LAND SEA AIR ORDNANCE

Reg. U. S. Pat. Off.

JOHN D. SMALL
Chairman,
The Munitions Board,
Department of Defense

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★ Double Production . . . . . A. M. Hamilton
★ Decisions of Destiny . . . . . William C. Bober

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The Magazine of Scientific and Industrial Preparedness

Vol. XXXVII NOVEMBER-DECEMBER, 1952 No. 195

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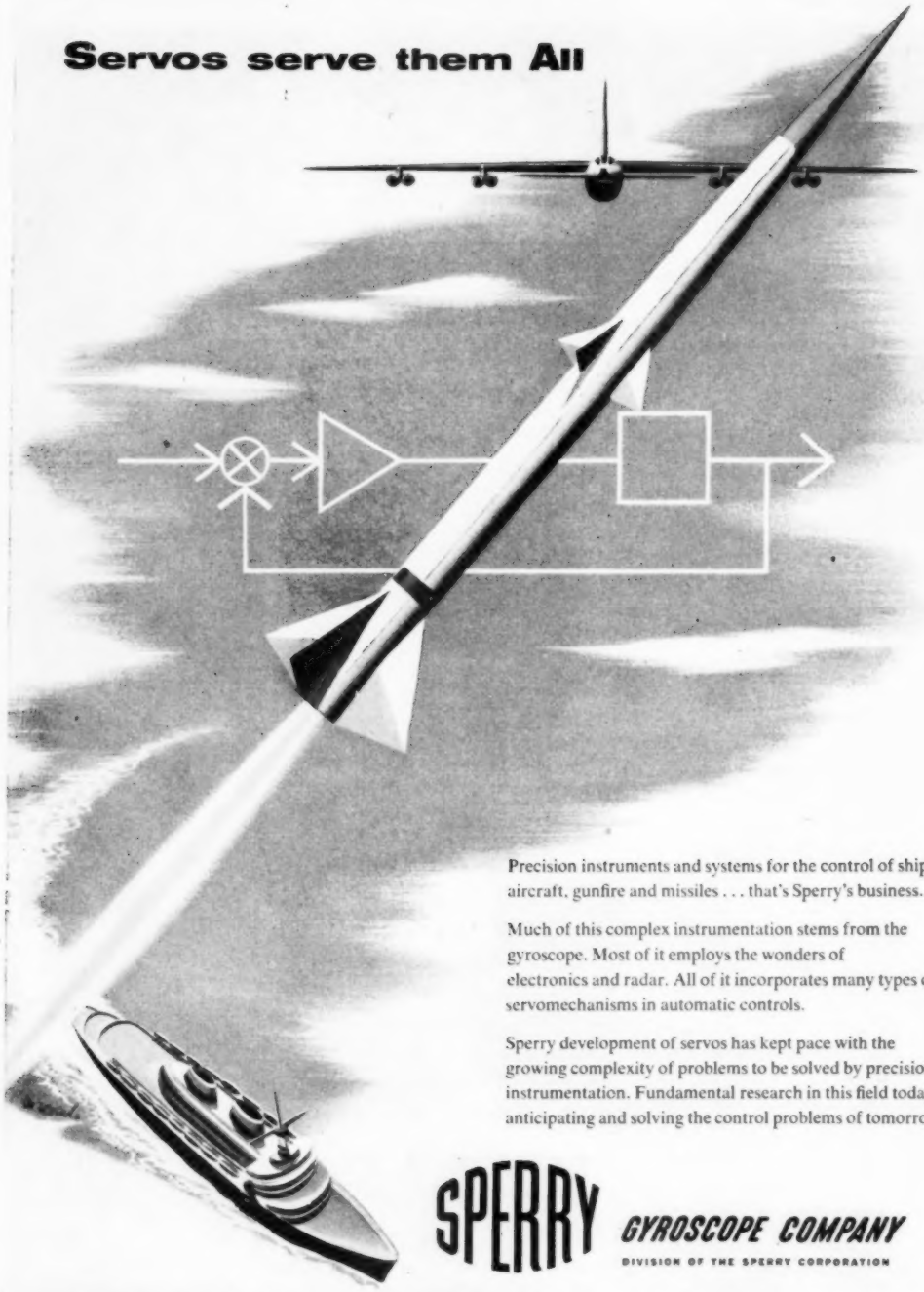

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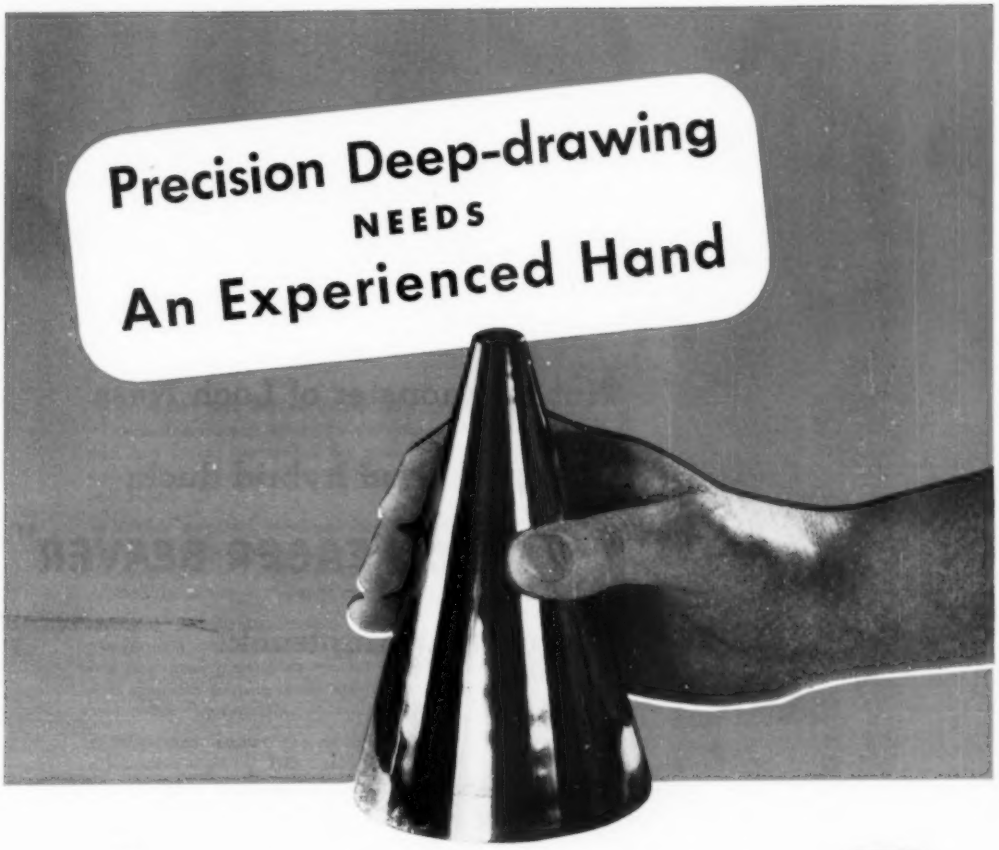

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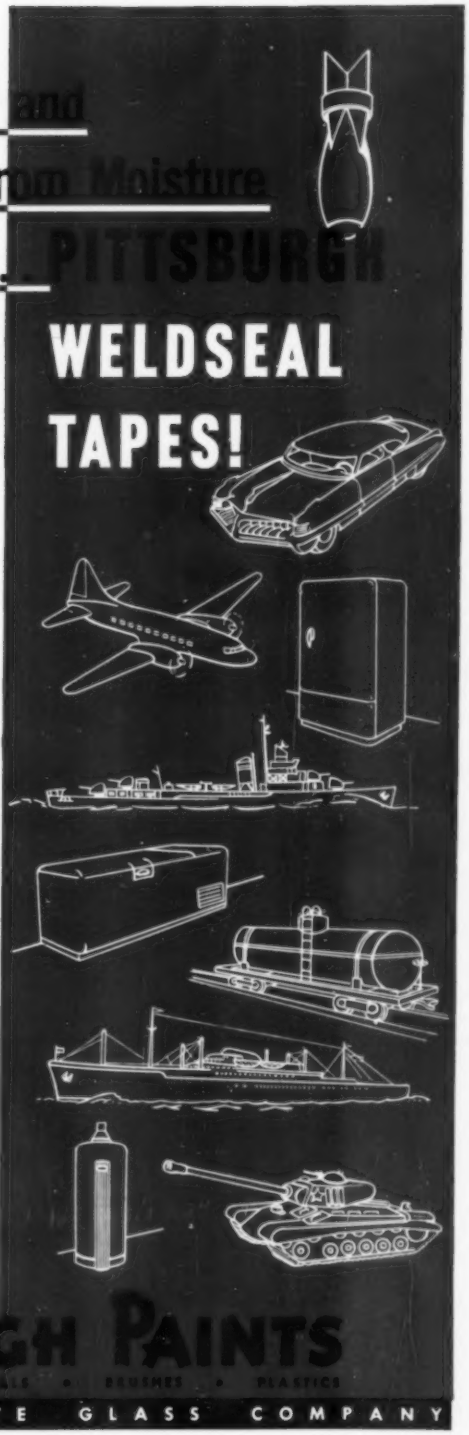

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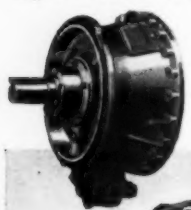

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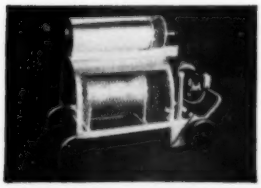

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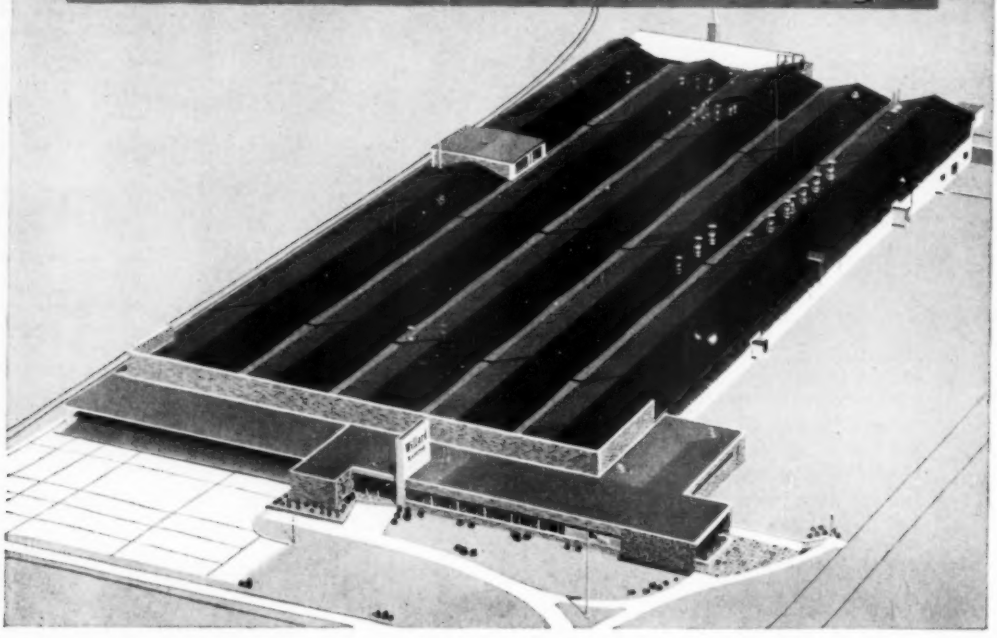

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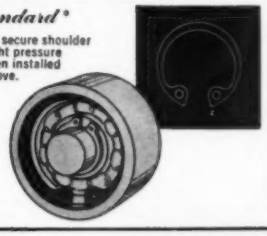

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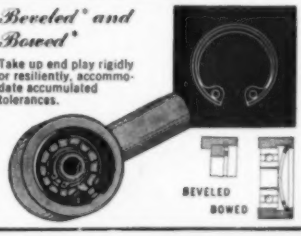

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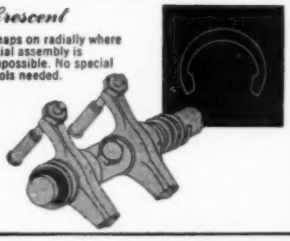
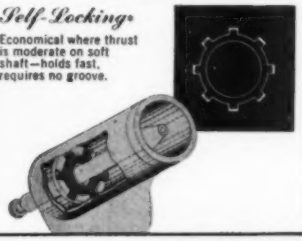


Self-Locking* — Economical where thrust is moderate on soft shaft—holds fast, requires no groove.



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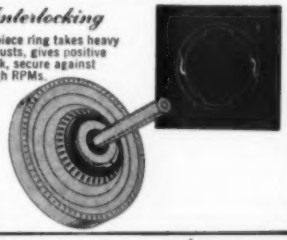

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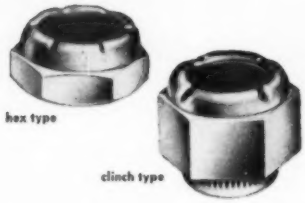

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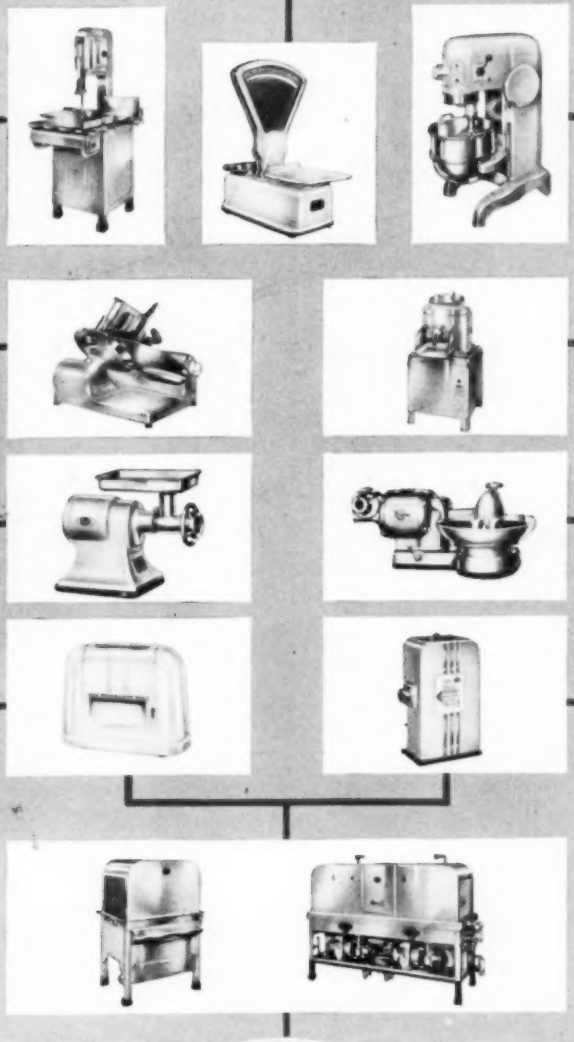

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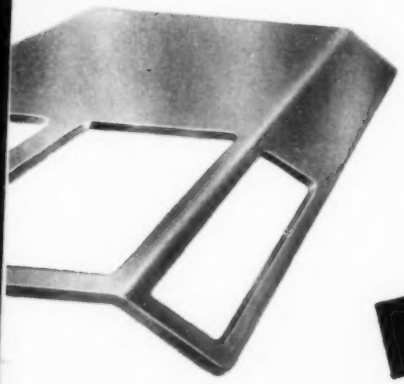

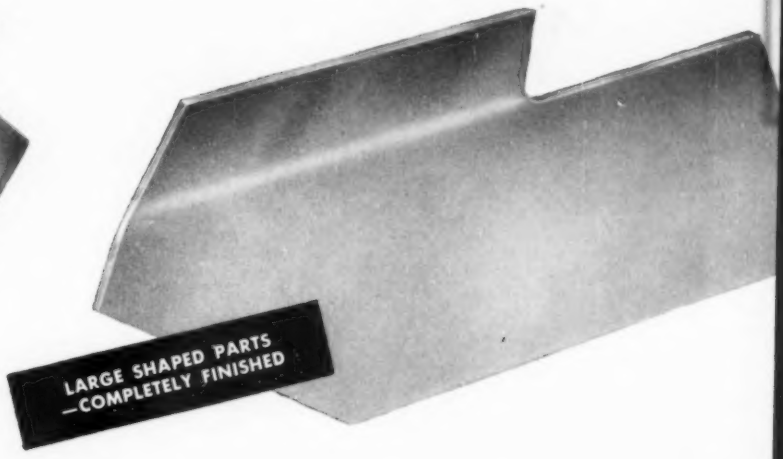

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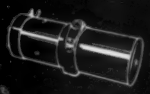

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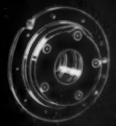

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NEW CORROSION INHIBITOR
STOPS RUST ...CUTS COSTS

If you make—ship—or store metal parts that rust can damage . . .

HERE'S IMPORTANT NEWS

New Shell "VPI" is effective in even the most difficult cases of rust prevention—and it's easy to use, too. "VPI" is a volatile corrosion inhibitor which comes in both crystal and paper wrap form.

Whenever moisture is in air, "VPI" vaporizes and makes air noncorrosive. "VPI" is applied quickly . . . containers do not have to be airtight. Container costs are reduced. Handling costs are lower because there's no greasing and degreasing . . . no need for expensive rust-removal jobs after part is unpacked.

Your Shell Representative can give you more information about the "VPI" method of rust prevention. Call him today. Or write to nearest address listed below.

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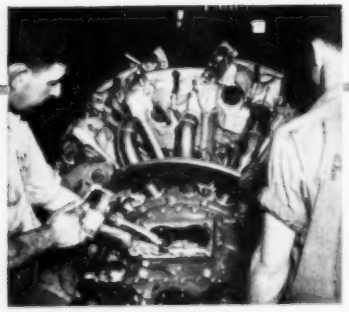
50 West 50th Street, N. Y. 20, N. Y.
100 Bush Street, San Francisco 6, Calif.

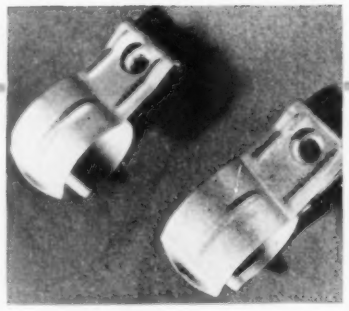
SHELL®

VPI

(a volatile corrosion inhibitor)

stops air and moisture from making rust.





"VPI" can be used many ways. The photo at the left shows powder being blown into critical areas of aircraft engines to prevent corrosion during storage. Photo at right shows identical spring clips stored 3 weeks in an open box. The upper clip was first sprayed with 4% "VPI" solution. Note that the "VPI"-treated clip suffered none of the rusting which is apparent on the lower clip.

a proven steel

FOR GAS TURBINE STRUCTURES

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AC9115 ALLOY STEEL

The production of gas turbines for jet aircraft engines and other uses is dependent upon metals which at both high and low temperatures have good strength, toughness, and stability before and after welding. N-A-X AC9115 ALLOY STEEL possesses these properties and is applicable to those parts where the operating temperatures range from 70° up to about 1000° F, and where suitable coatings are used for surface protection against normal and hot corrosion.

N-A-X AC9115 ALLOY STEEL has outstanding cold forming and welding characteristics and conserves critical alloys in its composition.

For more information about N-A-X AC9115 ALLOY STEEL, send for our new booklet.

A New Booklet For Design Engineers

Write for this 16-page booklet on N-A-X AC9115 ALLOY STEEL. It describes the properties and characteristics of this material and offers information on its fabricating and welding properties.

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N-A-X Alloy Division • Ecorse, Detroit 29, Michigan
NATIONAL STEEL CORPORATION

Makers of the famous N-A-X

All-Purpose Military Tractor

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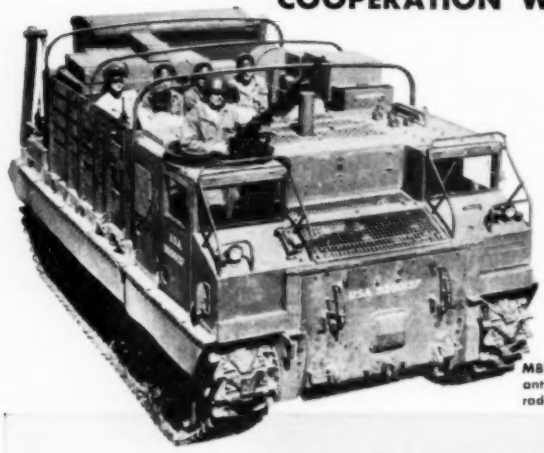
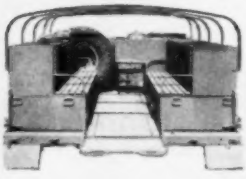


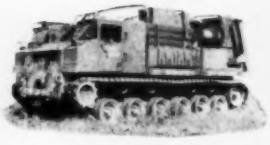
For fast transport of supplies and personnel over steep and difficult terrain . . . for hauling big guns, moving earth, clearing wreckage—on any of a dozen job's, it's "front and center" for the M8E2 Cargo Tractor. Various adaptations of the basic model make this versatile, all-weather machine a specialist on every assignment.

M8E2 CARGO TRACTOR. Two separate seats carry driver and assistant driver. Assistant has access to limited dual controls . . . operates radio and .50 calibre machine gun.

BASIC UNIT is so designed that it may be easily adapted for each of many specialized applications. To simplify servicing and stocking of parts, many M8E2 major components and parts are interchangeable with those of vehicles in the light tank family.



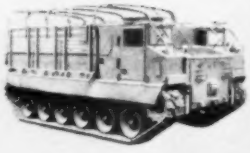
EQUIPPED WITH AMMUNITION RACKS and seats for gun crew, the M8E2 is used to tow heavy artillery.



SKY SWEEPER KIT includes power unit and generator for use with radar and A.A. guns.

WITH BULLDOZER BLADE, the M8E2 quickly levels gun emplacement areas . . . handles other special 'dozing assignments.

SPECIAL WRECKER EQUIPMENT enables this giant military tractor to quickly salvage damaged equipment of all kinds.



WITH STAKE BODY, this powerful prime mover quickly hauls supplies and personnel into remote areas where trucks cannot operate. Travels up to 40 mph. . . . takes slopes as steep as 60 percent.

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TRACTOR DIVISION — MILWAUKEE 1, U. S. A.

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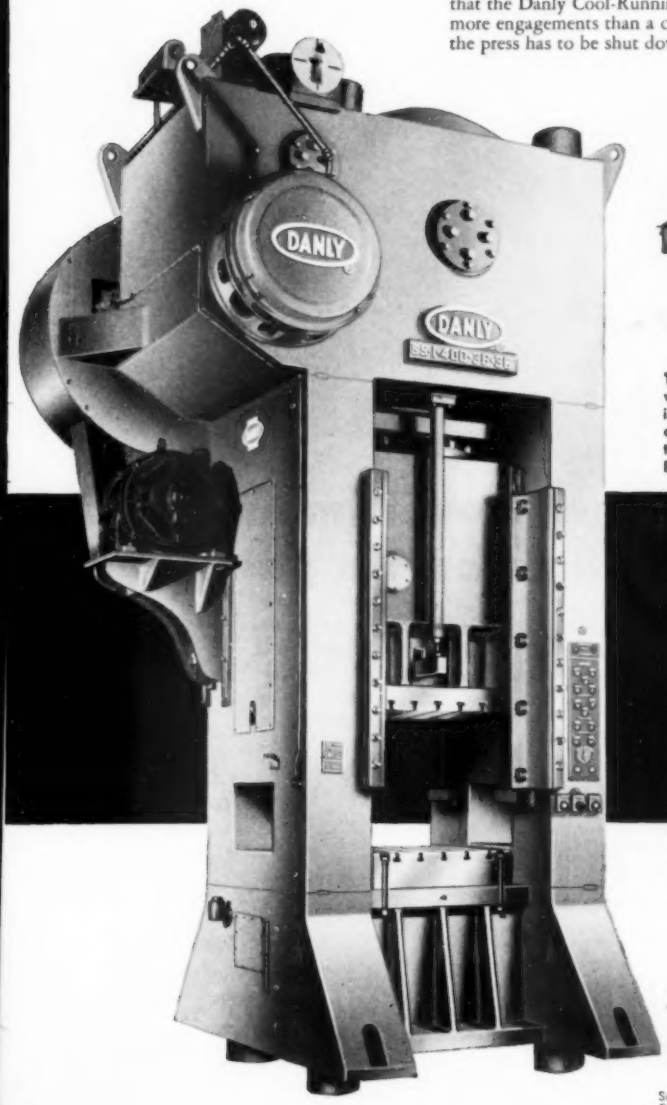
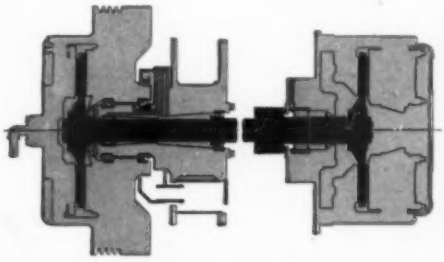
DANLY PRESSES are setting new production records in big stamping plants all over the country. One exclusive Danly feature alone, the Cool-Running Clutch, accounts for tremendous savings in costly press down time. Actual production tests show that the Danly Cool-Running Clutch withstands up to 7 times more engagements than a conventional press clutch before the press has to be shut down for clutch take-up.





The Danly Cool-Running Clutch . . .
wears longer because the rotating parts (shown here in black) "picked-up" on clutch engagement weigh only 1/5 as much as those of a conventional clutch. Energy required to pick up all moving parts, gears, slide and dies, is reduced by 2/3—a tremendous saving in power and clutch life.

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Bazooka shell assemblies get their protective finish with DeVilbiss Automatic Spray Equipment

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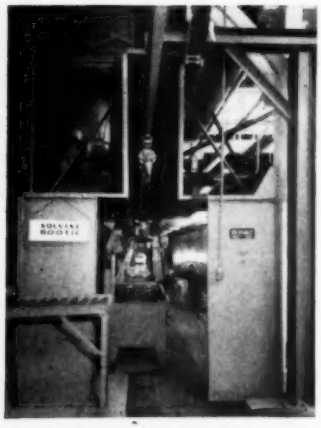

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W-S Hydraulic Press flexibility of control is a natural for the precision required in shell forging manufacture. Combine this control with the economy of using only the press tonnage and stroke required and the exactly suitable speed and you have the answer to every pressing operation.

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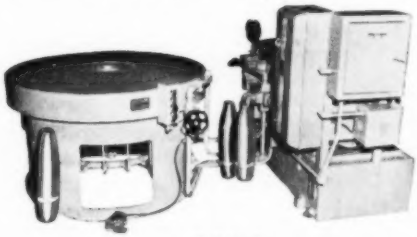
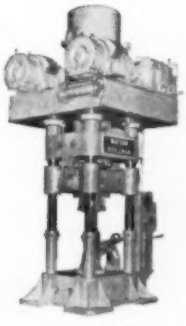
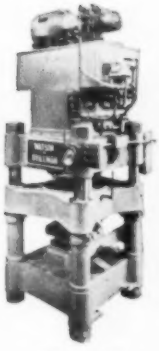


Shell Bander



Shell Nosing Press



Billet Breaker

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for Piasecki "Work-Horse" Spars

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Forged tubes delivered to Tube Reducing Corporation by Piasecki are processed into spars by the Rockrite compression forming method. Since the Rockrite method further cold forges the tube, it imparts better mechanical properties to the metal, which improves the structural strength of the original tube. Also, the process sizes the tubes so accurately that it simplifies the essential balancing of the rotor blades.

Piasecki engineers report that the better control of close dimensional tolerances, wall thickness and concentricity possible with Rockrite-processed spar-tubes has reduced their machining costs to a minimum.

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TUBE REDUCING CORPORATION · WALLINGTON, NEW JERSEY

MIL-P-116A, Military specification for Methods of Preservation dated March 25, 1952, Method IIc "Cushioned Item Bag" (five pound weight limit).

READ AND SAVE THIS ISSUE FOR FUTURE REFERENCE

MILITARY PACKAGING SIMPLIFIED 5 of a series

1. Fragile part ready for application of dry, neutral cushioning material. Weight of object being packaged cannot exceed five pounds.

2. Application of cushioning, with proper unit of desiccant included. After wrapping, apply tape if necessary to hold material snugly to part.

3. Cushioned part inserted in pouch constructed of MIL-B-131A Class D material. Pouches should be sufficiently large to avoid any strain on heat-sealed seams.

4. Completed unit package. Properly identify contents and apply Method II warning label before placing in carton.

Note: *MIL-P-116A was approved by the Departments of Army, Navy, and Air Force for use of the procurement services of the respective departments.*

FREE MANUAL

Write on your stationery for this free Military Packaging Handbook. It will save you time and money.

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Reynolds has perfected a new method of applying polyethylene to foil-backed stock for military packaging, which is a great advance over the old method of laminating it as a film. The result is a barrier material exceptional in both efficiency and economy. Reynolds RM-245, shown in the application illustrated here, is produced by this new process. It is composed of foil laminated to kraft, then polyethylene applied to the foil for heat-sealing as well as stretch characteristics. Performance tests have proved this material highly satisfactory for packing small fragile objects (not over 5 lbs.), and it cuts costs.

Reynolds RM-151, consisting of cloth instead of kraft, is also produced by this new cost-cutting method and is available for Method IIa and Method IIb packaging. This material also exceeds MIL-B-131A performance tests.

For expert help on any packaging problem call your nearest Reynolds Aluminum Sales Office and ask for "the packaging man"; or write **Reynolds Metals Company,** 2500 South 3rd Street, Louisville 1, Ky.

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This FREE Booklet Tells You How

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- How can cleaning costs be reduced 33⅓% while plating quality is being improved? *See pages 7 and 8.*
- What are four easy ways to improve the average rinse tank? *See page 10.*
- What rinsing fault is "an invitation to trouble" in the plating of high-carbon steel? *See page 11.*
- Why is it better to clean steel with reverse current than with direct current? *See pages 12 to 14.*
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What's best when steam is not available? *See page 7.*

What is the cheapest way to strip metal parts in large volume? *See page 9.*

What are the best ways to prepare stripped surfaces for repainting? *See page 11.*

What strippers are best for removing oil-base paints? . . . Synthetic enamels, alkali-resistant plastics or resin-based paints? . . . Japans, wrinkle finishes, nitrocellulose lacquers, alkyds, phenolics and ureas? *See page 12.*

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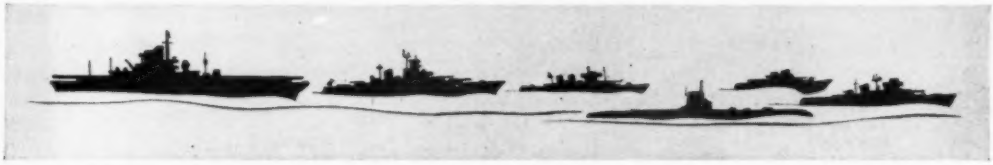

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POWER where you want it...when you want it

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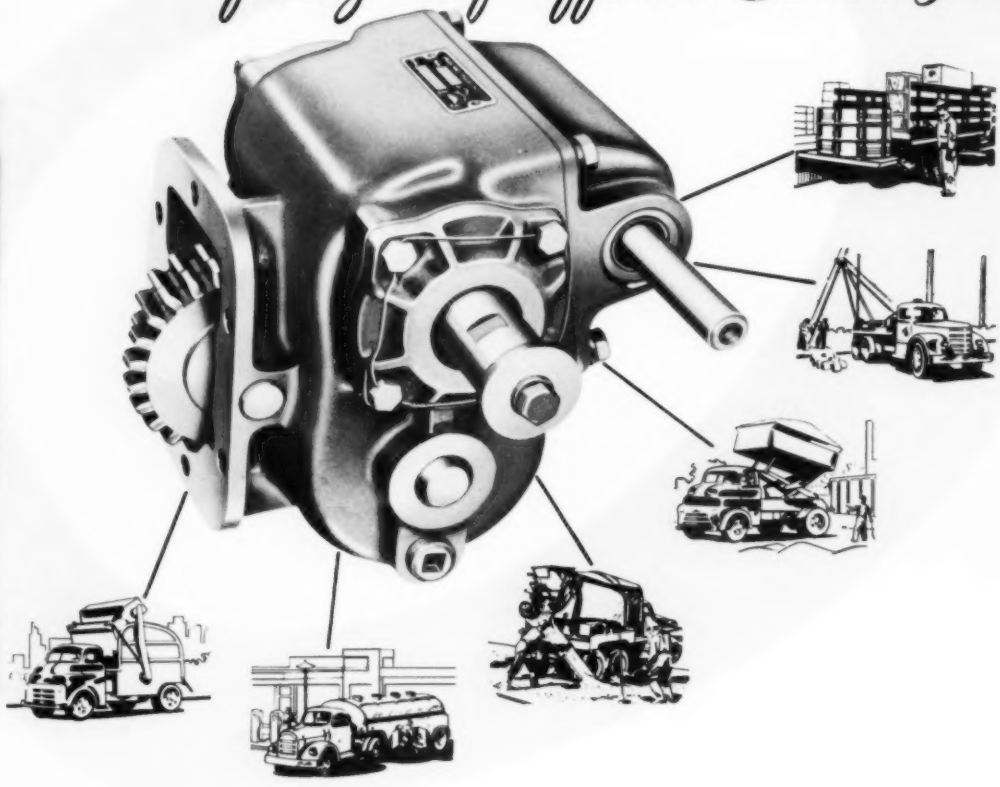

Spicer Brown-Lipe Power Take-Offs and Power Take-Off Joints are available in a wide range of models to meet every service requirement. These units are considered standard by the automotive industry, and are more widely used than any other similar types of equipment.

Spicer Brown-Lipe Power Take-Offs are designed to meet all operating conditions of continuous or intermittent service. All gears used are made from chrome nickel molybdenum steel forgings, annealed and case-hardened, insuring the longest possible service life under severe operating conditions.

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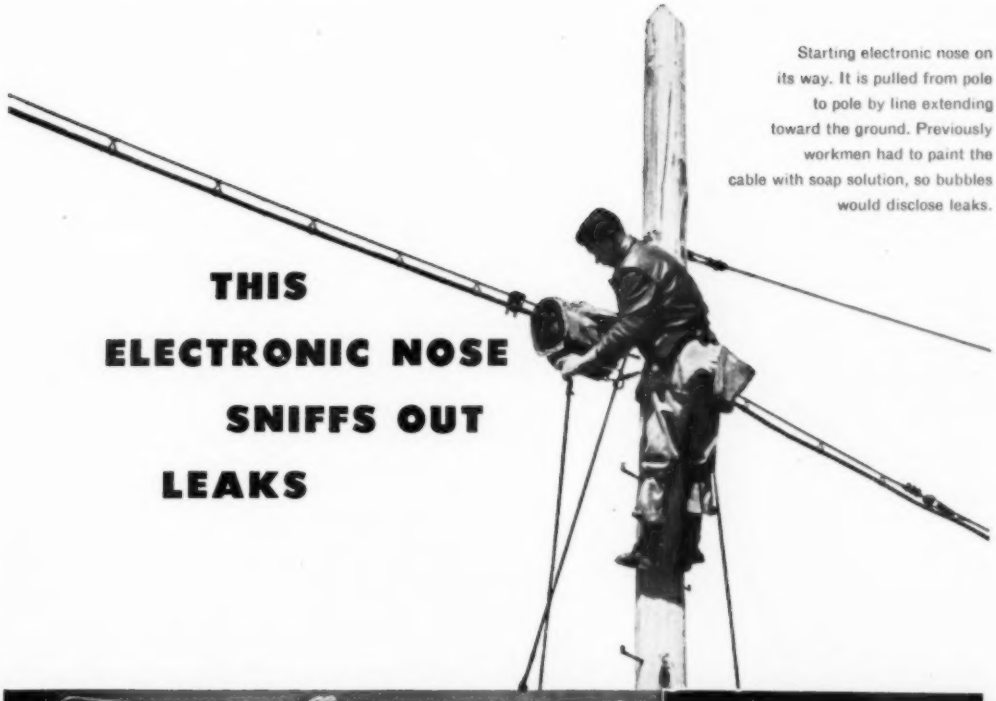
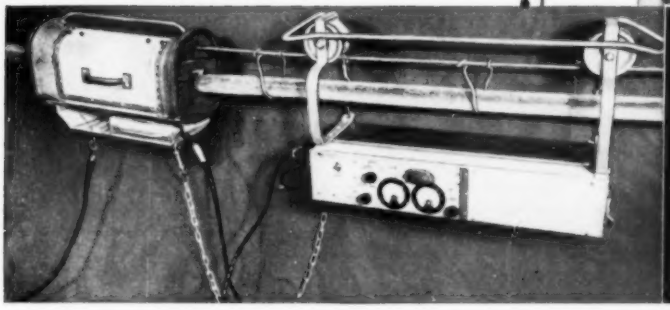
PASSENGER CAR AXLES • SPICER "BROWN-LIPE" GEAR BOXES • PARISH FRAMES • TORQUE CONVERTERS
POWER TAKE-OFFS • POWER TAKE-OFF JOINTS • RAIL CAR DRIVES • RAILWAY GENERATOR DRIVES



Starting electronic nose on its way. It is pulled from pole to pole by line extending toward the ground. Previously workmen had to paint the cable with soap solution, so bubbles would disclose leaks.

THIS ELECTRONIC NOSE SNIFFS OUT LEAKS



For test, the cable is cleared of protective nitrogen or air, and filled with Freon gas. Case at left collects escaping gas which operates Freon-sensitive detector underneath. At points where Freon escapes through sheath cracks, the box at right—a combined control unit and power supply—rings a bell. Workmen mark the point of leak for later repair.

After years of buffeting by the wind, even tough telephone cable sometimes shows its age. Here and there the lead sheath may crack from fatigue or wear through at support points. Before moisture can enter to damage vital insulation, leaks must be located and sealed.

To speed detection, Bell Laboratories scientists constructed an electronic nose which *sniffs* out the leaks. Using an electrically operated element developed by the General Electric Company, the device detects leaks of as little as 1/100 cubic foot per day. Sheath inspection can be stepped up to 120 feet per minute.

Thus Bell scientists add findings in other fields to their own original research in ways to make your telephone system serve you better. On the other hand their discoveries are often used by other industries. Sharing of scientific information adds greatly to the over-all scientific and technological strength of America.

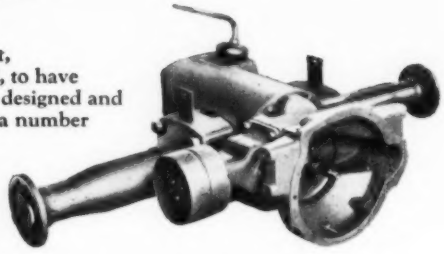
BELL TELEPHONE LABORATORIES

Improving telephone service for America provides careers for creative men in scientific and technical fields

This pocket size book briefly describes and illustrates Clark Products. You are invited to send for it.

designed especially for your machine...

A CLARK DRIVE UNIT



It's good news for heavy duty equipment, agricultural or industrial, to have a transmission-axle unit designed and built by CLARK—and a number of leading manufacturers have proved it to their own thorough satisfaction.

Calling in CLARK engineers to collaborate in designing a new machine or redesigning an old one, is a good way to take advantage of CLARK's unique experience in the field of transmitting motive power.

This is certain: By adopting that sensible *policy* you have nothing to lose—and a great deal to gain in the greater efficiency and dependability of your product.

PRODUCTS OF CLARK — TRANSMISSIONS • AXLES • AXLE HOUSINGS • TRACTOR DRIVE UNITS • FORK TRUCKS AND TRACTORS • POWERED HAND TRUCKS • GEARS AND FORGINGS • ELECTRIC STEEL CASTINGS

CLARK EQUIPMENT COMPANY • **BUCHANAN, MICHIGAN**

Other Plants: BATTLE CREEK *and* JACKSON, MICHIGAN

Buttoned-up and navigating blind

Operating tanks with full effectiveness in featureless arctic or desert terrain presents a new problem in "blind" navigation.

Dead reckoning and navigating under such conditions requires electronic and electromechanical systems that are highly complex yet simple to operate and maintain.

This growing field of vehicular navigation is another place where Arma is a leader in basic research, design, development and production. Over 34 years of close cooperation with the Armed Forces—and more recently the Atomic Energy Commission—stand behind Arma's reputation. *Arma Corporation, Brooklyn, N. Y.; Mineola, N. Y.; Subsidiary of American Bosch Corporation.*

ARMA ADVANCED ELECTRONICS FOR CONTROL

60

WIREBOUND BOX PLANTS

are ready to serve you!

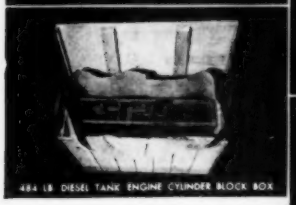
ALL FULLY INFORMED ON SPECIFICATIONS
AND REQUIREMENTS OF ALL GOVERNMENT BRANCHES

Strategically located to serve suppliers of all government services, Wirebound Box manufacturers are in excellent position to meet your shipping container needs. Parts boxes, equipment crates, over-packs and food containers are but a few of the multitude of uses for which Wirebound containers are adaptable. Wirebound manufacturers are informed, experienced and technically trained to design, produce and pre-test scientific containers for each use. Make it a point to consult your nearest Wirebound supplier or write for full information.

Wirebound Box Manufacturers Association
Room 1163, 327 South LaSalle Street, Chicago 4, Illinois

CYLINDER BOX

IMMERSION HEATER BOX


484 LB DIESEL TANK ENGINE CYLINDER BLOCK BOX

FIELD RANGE CRATE

CHEMICAL BOMB BOX

TYPICAL [illegible] OVERPACK

PROJECTILE BOX

PRACTICE BOMB CRATE

Wirebound
BOXES & CRATES
Users names on request

Remington Rand Methods News

How to get better maintenance from smaller inventory

There's a firm of 2,000 employees operating on a total maintenance inventory of only $30,000 *which turns over at the rate of nine times a year.* What's more, they don't have to worry about running short of any part or material needed to keep the machines running.

This achievement was made possible by centralizing the inventory records and the purchasing of maintenance supplies under a control system which Remington Rand designed and installed.

Previously, individual department heads had done much of their own buying. This led to wasteful duplication of stocks. Likewise, they passed up the valuable savings of volume buying because each plant bought from its own sources. Nor could they get the service which comes with planned buying.

Previously, an entire department might be shut down for lack of a single part in the stock room when it was needed. Now the stocks cannot fall below a safe minimum on any item without management knowing about it.

Reducing the total stock has also reduced the stockroom space for maintenance items. And the stockroom clerks have less paperwork to do. Let us show you how such a system can work for small plants or large. Ask for our new methods file **MC-802.**

SENIORITY SO YOU CAN SEE IT. A good way to prevent or settle disputes is this visible list of employees by seniority rating. Can be kept up to date for years without retyping. Names can be inserted or removed without disturbing sequence. Lists by trade or department can also be displayed publicly on your plant bulletin boards. See details in our manual X-521.

FASTEST KNOWN WAY TO PRODUCE YOUR PAYCHECKS. Let us show you a new Stub-Check payroll system which pays for itself in savings on check forms alone; also eliminates many clerical work steps. This plan not only helps you meet payroll deadlines with less confusion — it also simplifies your entire payroll operation. Just ask for folder AB-569.

How a plant got back on schedule by coordinating its control procedures

In this case, the production facilities were ready when the sales mushroomed as expected. Things went fine for a year or so. Then, suddenly, the orders were backing up in the shop. Some machines would have a big backlog of work while others were idle.

Was the problem simply one of poor machine loading? Or had the whole control system been outgrown? After talking it over, the plant executives decided to call Remington Rand for an outside viewpoint and professional counsel on the entire production control system.

A preliminary study by our management engineers showed the problem went much deeper than machine-load scheduling. So our engineers were authorized to dig to the bottom of the problem.

In their final report, these engineers proposed simple ways to get complete, accurate control over all phases of production – including materials, tools and inspections. New forms and methods were developed to simplify the work on operation sheets, and other factory paper. Flow charts showed how to correlate the flow of work between production, engineering, purchasing and sales.

When these recommendations were put into effect, the plant ran like a different place. No more snarls in machine loading. They got back on schedule – and stayed there. In fact, sales doubled again in the next three years and the control system continued to process a growing volume with the same smooth-working efficiency.

Let us give you the case history of this plant and its experience with simplified control methods. Ask for folder **SN-724.**

Remington Rand

Management Controls Reference Library
Room 1491, 315 Fourth Avenue, New York 10

Please circle the literature you desire:

MC-802 X-521 AB-569 SN-724

Name_____

Title_____

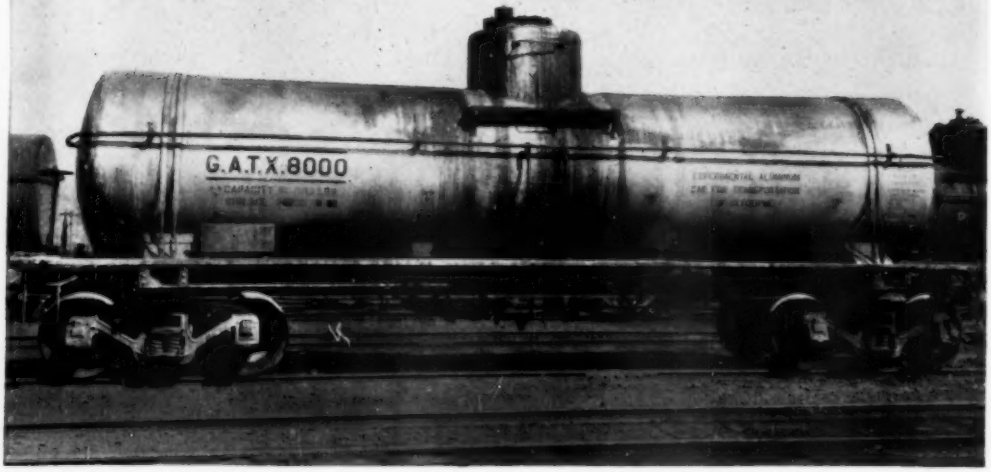
Firm_____

Address_____

City_____ Zone_____ State_____

THEY MADE HISTORY!

This car, and the men who designed it



Back in 1928 Alcoa engineers pointed out the advantages that aluminum would bring to railroad tank cars carrying hard to hold chemicals; easily contaminated foods. So Alcoa designed and undertook to pay for the first aluminum tank car. The car builder and a shipper became interested. On completion of the car, the builder assumed the cost and leased it to the shipper for regular service.

Interest in aluminum tank cars increased. Impact recorders and strain gauges gave the designers new data. The aluminum production men rolled the heaviest plate; made the largest rivets produced up to that time. The second car was made from 8 instead of 16 plates. Joining time cut in half!

Today three plates, plus heads, joined by newly developed welding methods make an aluminum tank car. And 1,300 of them, including the first one ever made, are in service.

Another instance where Alcoa engineering and co-operation have brought the advantages of aluminum to a new application. The same research, test and development facilities stand ready to help you make the best possible use of aluminum for defense needs.

ALUMINUM COMPANY OF AMERICA
850L Gulf Building · Pittsburgh 19, Pennsylvania

A business built on co-operation

ALCOA®

ALCOA
ALUMINUM COMPANY OF AMERICA

ON THE "FRONT LINE" IN COMMUNICATIONS

The rich experience and vast facilities of Delco Radio are again at the service of the nation!

Delco Radio has a major part in the current rearmament program . . . is currently producing advance-type radio equipment for many branches of the military. Delco Radio products serve equally well in civilian communications . . . in millions of passenger cars and trucks . . . in untold numbers of homes. Yes, in peace as in war, Delco Radio is on the front line in communications with on-time production of *superior* products. See for yourself!

DELCO RADIO

DIVISION OF GENERAL MOTORS, KOKOMO, INDIANA

LEADER...

IN PRODUCTION

Delco Radio is the world's largest builder of automobile radios . . . the leader in production and assembly of component parts.

LEADER...

IN ENGINEERING

Delco Radio developed many of the most important advances in automotive radio . . . has unsurpassed experience in this field.

LEADER...

IN QUALITY

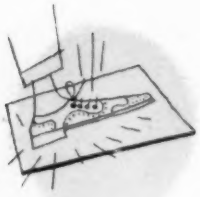
Every step in the manufacture of Delco Radio products is closely supervised to maintain high, uniform product quality.

LEADER...

IN MANUFACTURING

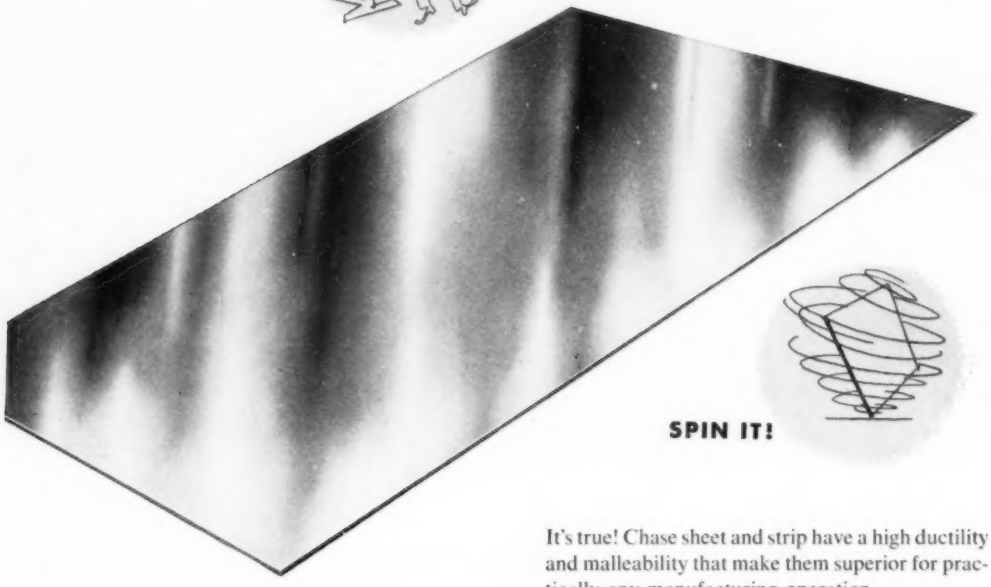
Completely integrated for efficient production, from raw material to finished product, Delco Radio meets any customer need.

Any operation is easier with CHASE® BRASS SHEET or STRIP

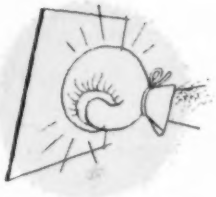


STAMP IT!

DRAW IT!



SPIN IT!



PUNCH IT!

SHEAR IT!

It's true! Chase sheet and strip have a high ductility and malleability that make them superior for practically any manufacturing operation.

Chase sheet and strip are carefully inspected for correctness and uniformity of width and gauge and freedom from oxides, dirt, grease and oil.

You can make very deep draws in a single operation . . . or often combine forming processes in making intricate shapes without intermediate annealing steps.

Check with your nearest Chase jobber or Chase mill warehouse. You stand to cut production costs when you insist on Chase brass sheet or strip.

Chase BRASS & COPPER

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

• *The Nation's Headquarters for Brass & Copper*

Albany†	Cleveland	Kansas City, Mo.	New York	San Francisco
Atlanta	Dallas	Los Angeles	Philadelphia	Seattle
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Boston	Detroit	Minneapolis	Providence	
Chicago	Houston†	Newark	Rochester†	(†sales office only)
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Why.....

magneto ignition?

BENDIX Magneto Ignition has traditionally been used on engines in critical installations where "keeping the engine going" is a "must."

BENDIX Magneto Ignition, an independent self-sufficient system, places no demands on a normally loaded electrical supply.

BENDIX Magneto Ignition produces a hot spark at all speeds.

BENDIX Magneto Ignition provides for ease of service due to its compactness and simplicity.

BENDIX Magneto Ignition minimizes fire hazard with elimination of supply leads.

BENDIX Magneto Ignition inherently provides superior radio-shielding and water-proofing.

BENDIX Magneto Ignition contact points and distributor electrodes have longer life because of inherent current reversal.

BENDIX Magneto Ignition has proven its efficiency, reliability and safety by its use on piston engine aircraft where no compromise is accepted.

Ordnance standards for material and equipment are necessarily the highest. Vehicles of all types must operate at maximum efficiency under every conceivable condition. Servicing must be accomplished simply and speedily, and long, dependable life for every component is a prime requisite. It is evident that magneto ignition provides the superior qualities that are required for ordnance vehicles.

Bendix

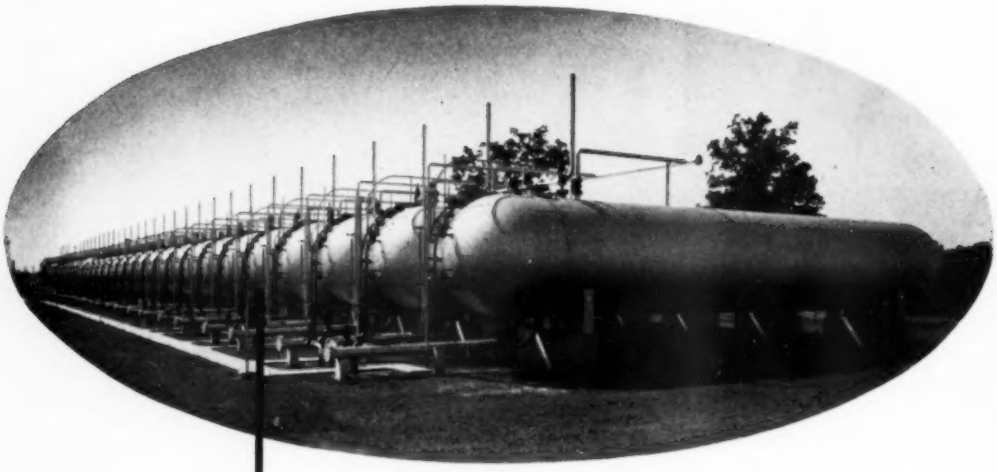
SCINTILLA MAGNETO DIVISION OF
SIDNEY, NEW YORK

Bendix
AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, New York

FACTORY BRANCH OFFICES: 117 E. Providencia Avenue, Burbank, California • Stephenson Building, 6560 Cass Avenue, Detroit 2, Michigan
Brouwer Building, 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • 582 Market Street, San Francisco 4, California

Another Example of Beaird Manufacturing Skill



PRESSURE STORAGE EQUIPMENT

Pressure tanks have been produced by the Beaird Company since its founding in 1918. Today, thousands of Beaird tanks are in use by the petroleum and chemical industries throughout the United States and in several foreign countries. They are manufactured under strict code requirements and are rigidly tested before shipment.

With this long experience in designing and fabricating pressure storage tanks, the Beaird Company is well qualified to handle large orders of steel fabrication for ordnance products.

Central location near Southwest ports

Ample supply of skilled labor

Modern manufacturing facilities

Experienced engineering staff

Trained inspection department

Strong financial position

SINCE 1918
BEAIRD
SHREVEPORT

MACHINING FABRICATING STEEL WAREHOUSE

THE J. B. BEAIRD COMPANY, INC. SHREVEPORT, LOUISIANA

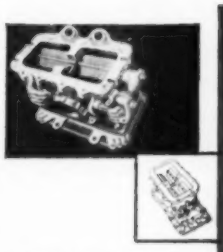
PACKAGED COMPRESSOR PLANTS | LP GAS SYSTEMS | CAST STEEL FITTINGS | ANHYDROUS AMMONIA EQUIPMENT | PRESSURE BULK STORAGE

Ever see a helicopter grit its teeth?

When this helicopter's giant blade spins, tiny two-inch Lycoming gears—machined to tolerances of 1/10,000 of an inch—carry the load!

"Sinews" to give cars "go"

For any or *all* engine parts—pistons, transmissions, crankshafts and other essentials that can "take it"—leading auto manufacturers look to Lycoming.



Watch a plane's "lung" take a deep breath

To inhale 30,000 pounds of air an hour, an engine needs good lungs—the Lycoming fuel-injection body that never leaks or coughs at any speed or altitude.

LYCOMING PRESENTS

a representative group of its achievements considered of outstanding importance by America's military and industrial leaders

For a more complete story on Lycoming write—on company letterhead—for the booklet "Let's Look at Lycoming."

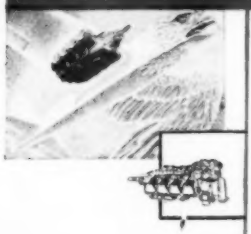
Here, through the eyes of a leading American illustrator, Lycoming demonstrates how it is geared to meet the most exacting requirements of America's leading industries. From basic research to precision and volume production, Lycoming offers a versatility of skills, extensive facilities and well-rounded experience. *Whatever* your problem—look to Lycoming!

AIR-COOLED ENGINES FOR AIRCRAFT AND INDUSTRIAL USES • PRECISION-AND-VOLUME-MACHINE PARTS • GRAY-IRON CASTINGS • STEEL-PLATE FABRICATION

LOOK TO **LYCOMING** FOR RESEARCH FOR PRECISION PRODUCTION

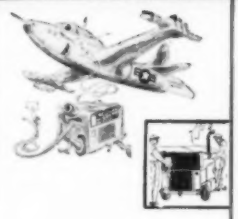
LYCOMING-SPENCER DIVISION, WILLIAMSPORT, PA.
BRIDGEPORT-LYCOMING DIVISION, STRATFORD, CONN.

AVCO manufacturing



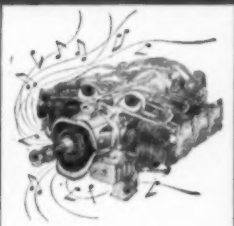
There's a new "beat" in this eagle's heart

Ready *reserve power* is an outstanding advantage of this sturdy new Lycoming aircraft engine—the only 400-horsepower air-cooled model produced today.



Hot "juice" for cold jets

This light, compact, portable Lycoming generator provides dependable all-weather starting power for jets—from 135° above to 65° below F.!



Its "song" fills the air

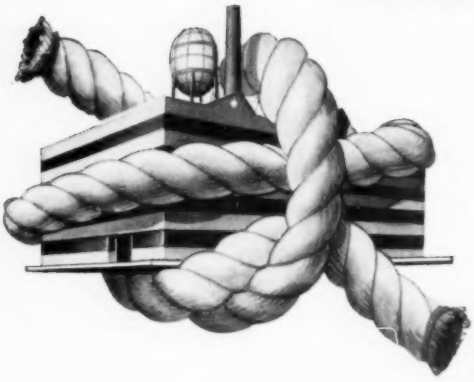
For dependable air-cooled engines in a wide horsepower range, many of the nation's leading aircraft manufacturers look to Lycoming!

AMERICA'S LEADERS LOOK TO LYCOMING

AIR MATERIEL COMMAND
BEECH AIRCRAFT CORPORATION
BELL AIRCRAFT CORPORATION
BENDIX AVIATION CORPORATION
CESSNA AIRCRAFT COMPANY
CHEVROLET-AVIATION ENGINE DIVISION
DETROIT TRANSMISSION, DIVISION OF GENERAL MOTORS
DOMAN HELICOPTER COMPANY
FORD MOTOR COMPANY
GENERAL ELECTRIC COMPANY
INTERNATIONAL BUSINESS MACHINES CORPORATION
NAVY BUREAU OF AERONAUTICS
OTIS ELEVATOR COMPANY
PHILCO CORPORATION
PIPER AIRCRAFT CORPORATION
PRATT & WHITNEY AIRCRAFT
RYAN AERONAUTICAL COMPANY
SYLVANIA ELECTRIC PRODUCTS, INC.
WESTINGHOUSE ELECTRIC CORPORATION
WRIGHT AERONAUTICAL DIVISION

ILLUSTRATIONS BY ARTZYBASHEFF

Are you all tied up in defense contracts?



DO YOU WANT TO INCREASE YOUR PRODUCTION FACILITIES?

Pressed Steel Car Company can accept subcontracts for the production of aircraft ground servicing equipment; aircraft and engine component parts; communication equipment; ordnance equipment; structures and component parts; cellular laminated wood products . . . and a wide variety of defense items.

In all, Pressed Steel Car Company has 7 manufacturing divisions and subsidiaries located in Chicago, Buffalo, and Mt. Vernon, Ill. Behind them is over a half century of experience in the manufacture of light and heavy industrial equipment.

Interested?

Contact the Contract Sales Department of Pressed Steel Car Company now.

A PARTIAL LIST OF THE PRODUCTS WE CAN PRODUCE!

Aircraft Ground Servicing Equipment
Dollies-Engine, Propeller & Special Types.
Stands—Maintenance, Servicing

Aircraft Component Parts
Containers—Ammunition, Equipment, Etc.
Engine Mounts & Exhaust System Parts.
Engine Shipping Containers

Communication Equipment
Chassis
Metal Housings

Ordnance Equipment
Launchers
Trailer Component Parts
Trailers

Cellular Laminated Wood Structures
Shelters
Trailers
Containers

Miscellaneous
Liquid Storage Tanks
Fabricated Sheet & Plate Weldments

Cellular Laminated Wood Products
From simple platforms and shipping containers to shelters and railroad cars.

PSC

PRESSED STEEL CAR COMPANY, INC.

Contract Sales Department

179 N. Michigan Avenue • Chicago, Illinois

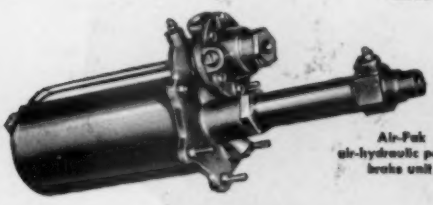
Either Way – YOU'RE ON THE ROAD TO BETTER POWER BRAKING!

There's no need to be puzzled about the question of efficient power braking for *any commercial vehicle*. Where the preference is for a hydraulic system, Hydrovac, with over two and a half million installations, has proven itself the undisputed leader in its field. And for vehicles where air actuated brakes are the choice, the new Bendix Air-Pak air-hydraulic power braking unit is foremost in its field.

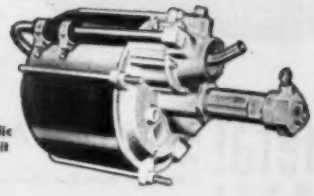
Air-Pak, similar in design and principle to the Hydrovac, changes air pressure into hydraulic pressure by means of two direct connected pistons, thus combining all the well proven advantages of hydraulic brake action with an air brake system.

Products of twenty-five years of practical braking experience, these outstanding power braking systems offer faster, more positive and better controlled braking. And in both the vacuum and the air actuated units, brakes can be applied instantly by foot power alone—a safety factor of tremendous importance. Remember, regardless of size of vehicle or whether your preference is for vacuum or air actuated brakes, for the industry's finest power braking systems—specify Bendix® Hydrovac® or Bendix Air-Pak.

®REG. U.S. PAT. OFF.



Air-Pak air-hydraulic power brake unit



Hydrovac vacuum-hydraulic power brake unit

BRAKING HEADQUARTERS for the AUTOMOTIVE INDUSTRY

BENDIX · PRODUCTS DIVISION · SOUTH BEND

Export Sales: Bendix International Division, 72 Fifth Ave., New York 11, N.Y. • Canadian Sales: Bendix-Eclipse of Canada, Ltd., Windsor, Ontario, Canada

Bendix Aviation Corporation

Bendix Products Division

★★★★★ **for domestic or export shipment...**

★★★★★ **for light or heavy products...**

★★★★★ **for large or small objects...**

there's a General engineered shipping container to meet military packing needs!

Pictured here is a General Wirebound box for the export shipment of 50-caliber ammunition. It combines strength and light weight. It is one of many types made by General —to meet military needs. Remember General when you have a military packaging problem. Container experts will be glad to design a package for your product, or help you with various specifications.

Write for your FREE *Copy of "The General Box." It shows how to cut packing and shipping costs.*

DISTRICT OFFICES AND PLANTS: Cincinnati, Denville, N. J., Detroit, East St. Louis, Kansas City, Louisville, Milwaukee, Sheboygan, Winchendon, General Box Company of Mississippi, Meridian, Miss., Continental Box Company, Inc., Houston, Dallas

General ★★★★★ BOX COMPANY

GENERAL OFFICES:
1865 Miner Street, Des Plaines, Ill.

First Things First

Today, as in previous emergencies, Blaw-Knox is concerned first and foremost with Defense requirements. Producing on schedule the urgently needed material and equipment for our Armed Forces calls for the same conscientious effort by Blaw-Knox personnel which was recognized by the award of seven "E's" during World War II.

BASIC PRODUCTS FOR INDUSTRY

- ★ ROLLS FOR STEEL & NON-FERROUS MILLS
- ★ ROLLING MILLS & AUXILIARY MACHINERY
- ★ OPEN STEEL FLOORING
- ★ PREFABRICATED PIPING SYSTEMS
- ★ OPEN HEARTH FURNACE EQUIPMENT
- ★ FIRE PROTECTION EQUIPMENT
- ★ CHEMICAL & FOOD PROCESSING EQUIPMENT
- ★ CONCRETE & ASPHALT ROAD PAVING MACHINERY
- ★ COMPLETE CHEMICAL & PROCESSING PLANTS
- ★ RADIO, TELEVISION & TRANSMISSION TOWERS
- ★ HEAVY STEEL CASTINGS
- ★ HEAT & CORROSION RESISTING ALLOY CASTINGS
- ★ STEEL FORMS FOR CONCRETE CONSTRUCTION
- ★ CONTRACTORS EQUIPMENT
- ★ CLAMSHELL BUCKETS

RECENT CATALOGS AND BULLETINS detailing practically all Blaw-Knox products are available, and any literature you request will be forwarded by return mail.

BLAW-KNOX COMPANY★

A Pacemaker for American Initiative and Ingenuity

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OPERATING AND SALES DIVISIONS—BLAW-KNOX • BLAW-KNOX SPRINKLER* • BUFLOVAK EQUIPMENT • BUFLOVAK MIDWEST CO. • CHEMICAL PLANTS* • THE FOOTE COMPANY, INC.** • LEWIS FOUNDRY & MACHINE • NATIONAL ALLOY STEEL • PITTSBURGH ROLLS • POWER PIPING* • UNION STEEL CASTINGS

*Operates as a division of Blaw-Knox Construction Co. **Subsidiary of Blaw-Knox Co.

★AWARDED SEVEN "E's" DURING WORLD WAR II

One DEMPSTER-DUMPSTER Serves Scores of Containers . . All Designs . . . All Sizes . .

Handling Materials of Almost Every Description at the Lowest Possible Cost!

One Dempster-Dumpster mounted on one of your trucks serves any required number of big detachable Dempster-Dumpster Containers spotted at convenient materials accumulation points inside and outside your buildings. The capacity of these containers range up to four times greater than the average dump truck body. They are built in a wide variety of designs best suited to the materials handled—be they solid, liquid or dust . . . trash or rubbish . . . bulky light or heavy. The truck-mounted Dempster-Dumpster, with only one man, the driver, picks up one pre-loaded container after another, hauls it to destination where materials are dumped or load set down intact. The Dempster-Dumpster may handle raw materials on one haul, liquids on another, trash and rubbish on another, etc. It's like having one truck with 15, 25, 65 or 100 different bodies.

This is the *Dempster-Dumpster System*—the modern method of bulk materials handling. It is saving thousands of dollars annually for hundreds of plants in every type of industry because it: Eliminates 3 to 5 conventional trucks and crews—reducing cost of truck equipment and operation accordingly. . . Eliminates standing idle time of trucks and crews. . . Eliminates re-handling of materials. . . Increases efficiency, sanitation and good housekeeping.

The *Dempster-Dumpster System* is, without question, the most efficient method of materials handling by truck ever devised! More efficient and lower cost materials handling in your plant may be simply a matter of getting the minds of your engineers and ours together. Write us now. The *Dempster-Dumpster System* is manufactured exclusively by Dempster Brothers, Inc.

WHEN A CONTAINER is full, the Dempster-Dumpster picks it up, hauls it to destination and dumps the materials or sets the load down intact. These three simple operations, shown above, are hydraulically controlled by driver in truck cab.

DEMPSTER BROTHERS, 9112 Shea Bldg., Knoxville 17, Tennessee

it's a matter of

PRECISION!

The lift, the power, the drive . . . yes, the air-borne heart . . . of the YH-21 Piasecki "WORK-HORSE" Helicopter are delivered by the three transmissions shown here . . . the forward, mid and aft. For *this* kind of component fabrication, the best single manufacturing asset is the PRECISION for which *Steel Products* is famous!

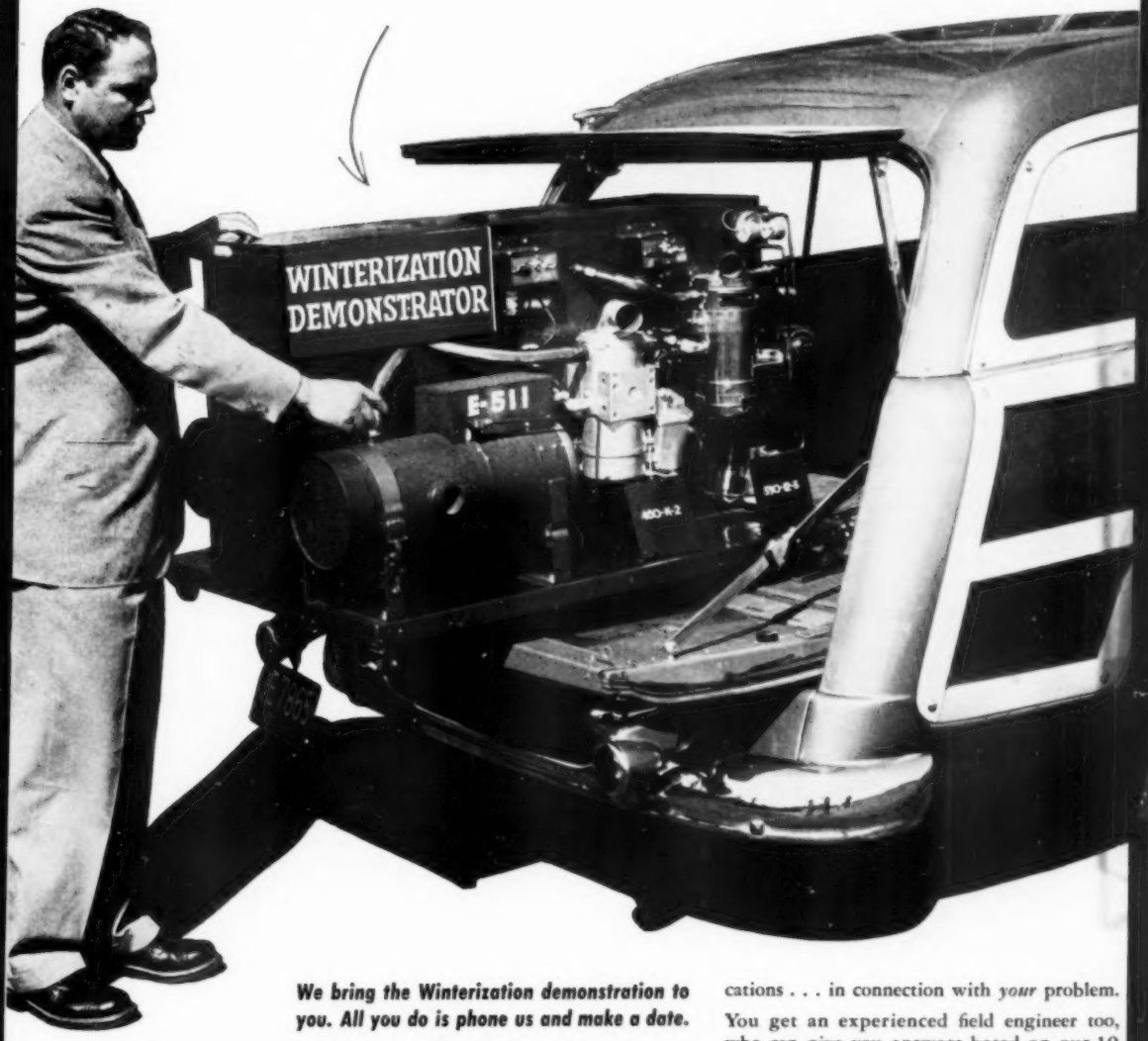
"Precision in Aviation Since 1914"

THE STEEL PRODUCTS ENGINEERING CO.

engineers and manufacturers • Springfield, Ohio

For over a decade
our entire organization and facilities
have been devoted exclusively to
the design and production of
FLARE AND SIGNAL MUNITIONS
PHOTOFLASH MUNITIONS
DETONATOR AND BURSTER COMPONENTS
FOR AMMUNITION
★ ★ ★
SHELL AND FUZE LOADING
AERIAL PRODUCTS, Inc.
ELKTON, MARYLAND

RIGHT AT YOUR DOORSTEP



We bring the Winterization demonstration to you. All you do is phone us and make a date.

On Perfection's Mobile Demonstrator you can see five different types of heaters—which are the heart of our Winterization Systems—in actual operation. They include fresh air and coolant types ranging from 20,000 to 60,000 B.t.u. capacities. You can try them, pry into them, weigh the advantages of each . . . or modifications . . . in connection with *your* problem.

You get an experienced field engineer too, who can give you answers based on our 10 years of designing and producing winterization systems—over 100,000 installations—for all sizes and types of vehicles and equipment. Winterization Data File on request. Perfection Stove Company, 7341-C Platt Avenue, Cleveland 4, Ohio.

Perfection

A Big Help in Metal Finishing!

United Chromium specializes in coatings to solve problems in

❶ electroplating ❷ organic finishing ❸ chromate treating

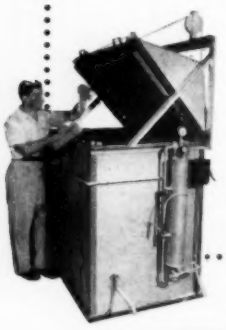
Need help in working with specification finishes in the above three groups? United Chromium, a specialist in coatings for metals for 25 years, can guide you both in the choice of the right finish, and in applying it properly at lowest cost.

Many Unichrome Coatings for Metals are widely used in ordnance finishing. They offer recognized advantages that can often save you trouble or expense, or keep you ahead on production. To illustrate:

HOW CHROMATE TREATING COSTS WERE REDUCED

A large automotive supplier is producing a corrosion-inhibiting finish on zinc die castings with more ease and less expense since switching from a "home made" chromate solution to a Unichrome Dip. This move reduced costs of materials alone by nearly a third. And there's less trouble getting as good or better corrosion resistance than before.

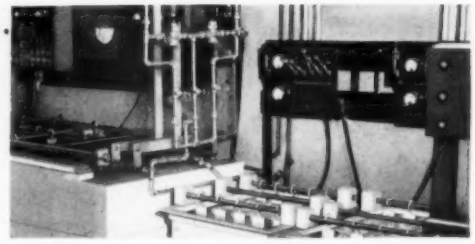
The black, olive drab, clear, and yellow finishes produced in Unichrome Dips can meet specifications on chromate treating.



CLEAR COATINGS THAT PASS TESTS

For years, United Chromium has specialized in developing clear synthetic coatings in order to fill the need for clear finishes that offer unusual protection to smooth or bright metals. Today, you can also count on quality Unichrome Clear Coatings for defense applications. One in particular is Unichrome Synthetic Varnish B-175C. Arsenal-tested, this phenolic coating conforms completely to requirements for brass shell and cartridge cases. It affords the needed flexibility, solids content, corrosion resistance, and can be applied by spray or dip.

REMARKABLE IMPROVEMENT IN CHROMIUM PLATING Hard chromium plating in the Unichrome S.R.H.S. Chromium Solution reduces plating time, control problems, finishing time, and costs. Here's why: This solution plates 20 to 80% faster than the ordinary bath. It plates with less "treeing" and levels over minor surface irregularities. A self-regulating bath, it needs less attention for good results. These features explain why one plant was able to halve production time on plated bushings by switching to this bath.



For help on your specific finishing problem, why not write or phone the United Chromium office nearest you?

UNICHROME Trade Mark **COATINGS for METALS**

UNITED CHROMIUM, INCORPORATED 100 East 42nd St., New York 17, N. Y.

Waterbury 20, Conn. • Detroit 20, Mich. • Chicago 4, Ill. • Los Angeles 13, Calif. In Canada: United Chromium Limited, Toronto, Ont.

On the double

...WHEN THE GOING IS ROUGH

About a million and a half yards of tough, loamy material had to be moved when Cecil Field's two new jet plane runways went in. Each of the double runways at the Florida field is 9,400 feet; average haul distances ran from 4½ to 5 thousand feet. To move all that soil and sand that distance in a hurry, Contractors L. G. Defelice & Son of New Haven, Conn., turned loose ten "Caterpillar" DW20 Tractors with ten W20 Wagons. Also on job were D8 Tractors, No. 80 Scrapers, No. 12 Motor Graders.

The DW20 Tractor is all-"Caterpillar" built, with power and capacity precisely balanced. It delivers a steady 225 HP at the flywheel and has good lugging qualities. Three-point suspension gives smoother oscillation and roadability, does away with frame twisting, prevents overloading of any one tire, wheel or spindle. Pulling a loaded wagon, the DW20 can hit 26.6 m.p.h.

The W20 Wagon hauls 25 heaped yards or 17 struck. A hydraulic ram regulates its doors from the driver's seat and dumping can be accurately controlled. And its huge, open-top hopper is an easy target for shovel operators.

Fred Sebastian, Project Manager at Cecil Field, summed up this big yellow team: "They can't be beat for power, speed and efficiency. They've far exceeded our expectations."

CATERPILLAR, PEORIA, ILLINOIS

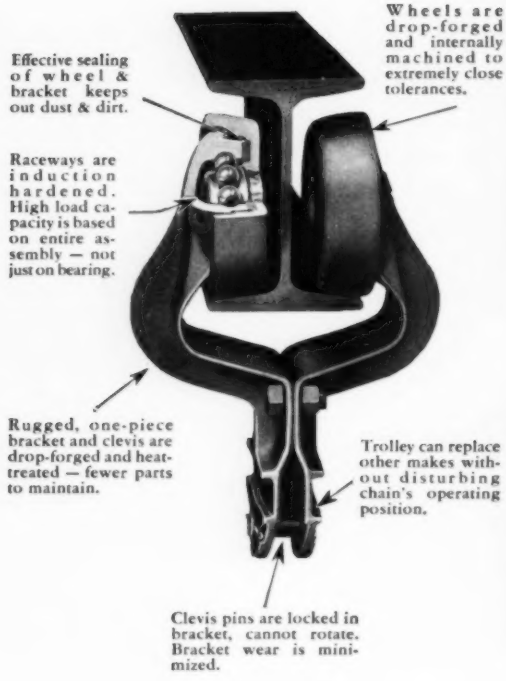
CATERPILLAR

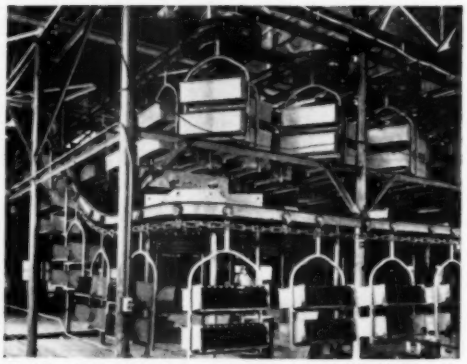
REG. U. S. PAT. OFF.

DIESEL ENGINES
TRACTORS • MOTOR GRADERS
EARTHMOVING EQUIPMENT

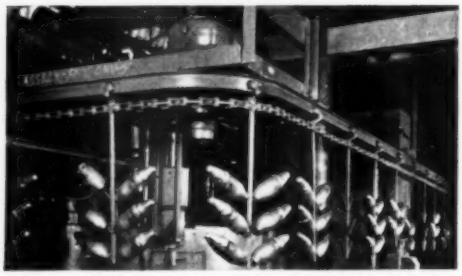
When you buy TROLLEY CONVEYORS why not get BOTH?

Superior components PLUS Engineering ingenuity


Effective sealing of wheel & bracket keeps out dust & dirt.
Wheels are drop-forged and internally machined to extremely close tolerances.
Raceways are induction hardened. High load capacity is based on entire assembly — not just on bearing.
Rugged, one-piece bracket and clevis are drop-forged and heat-treated — fewer parts to maintain.
Trolley can replace other makes without disturbing chain's operating position.
Clevis pins are locked in bracket, cannot rotate. Bracket wear is minimized.



Building 3.5-inch rockets, modern version of World War II bazooka, with the help of Link-Belt Overhead Trolley Conveyors. This parts storage conveyor, 600 feet long, has 180 carriers, spaced 40 inches apart.



Steel bodies for these 3.5-inch rockets are carried on this 112-foot-long Link-Belt Overhead Trolley Conveyor. The carriers, spaced 30 inches apart, were also made by Link-Belt.

YOU can make your overhead trolley conveyor dollars go farther by calling in Link-Belt while you're still in the planning stage. Link-Belt makes the finest trolley on the market today. Equally important, our specialists can draw on the world's largest, most varied background of conveying and power transmission application.

Bringing parts to workers and taking them away. Drawing raw materials from stock at correct intervals. Synchronizing operations to eliminate bottlenecks.

Link-Belt Overhead Trolley Conveyors do all these jobs to release valuable manpower for productive work . . . to increase output. And they free floor space, too.

Why not have a Link-Belt engineer help you and your consultants plan peak production results? Write for Book 2330 for all the facts.

LINK-BELT

OVERHEAD TROLLEY CONVEYORS

LINK-BELT COMPANY: Chicago 8, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices in principal cities. 12,411-A

For Lack of Warning... Long Island Is Lost!
JAMAICA PASS, LONG ISLAND, AUG. 27, 1776. —An enemy patrol surprised and captured five mounted American officers at this vital pass today. Had at least one of the five escaped, a warning might have been given. Instead, British General Clinton was able to complete his encircling maneuver and, with General Heister's regiment in front of the Americans and his own in the rear, successfully routed our main body.
At the time of the
were . . .

CHRYSLER AIR RAID SIREN

can warn a circular area 8 miles in diameter

As a result of their victory at Long Island in 1776, the British were able later to take New York and begin other successful campaigns along the Atlantic seaboard.

All history is filled with military disasters to armies and peoples, which could have been prevented, had adequate warning been given of the impending attack.

Today, a system of Chrysler Air Raid Sirens, remote-controlled by ingenious utilities circuits, can warn an entire city in a matter of *seconds!* Thanks to the unusual power characteristics of its mighty 180-horsepower industrial V-8 engine, each Chrysler Siren can send a shrill, vibrant warning *four miles in every direction.* No other siren available today can match such performance. Civil Defense officials in many cities have discovered that the tremendous power of the Chrysler Siren means fewer units for complete coverage.

Each Chrysler Siren has its own self-contained power plant and is designed for operation by remote control or manually, should the situation require it. This means, too, that Chrysler Sirens can be used on moving trucks or boats for added safety or convenience.

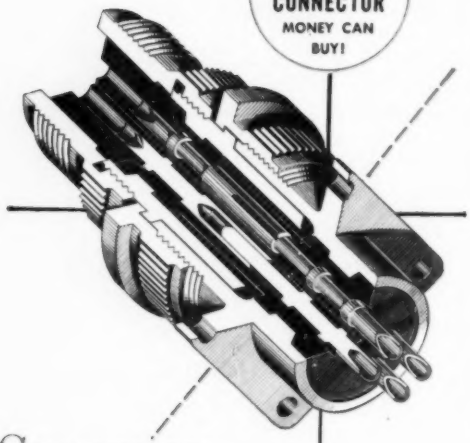
Your own comparison will prove the greater economy, efficiency and practical advantages of a warning system employing Chrysler-engineered Sirens. For specifications and information on what protection your community requires, write . . . ***Siren Layout Service, Marine and Industrial Engine Division, Chrysler Corporation, Trenton, Michigan.***

Defense is a vital need, shared by all. Join and assist the Civil Defense group in your area.

CHRYSLER

AIR RAID SIREN

The Finest
ELECTRICAL CONNECTOR MONEY CAN BUY!



SCINFLEX **ASSURES LOW MAINTENANCE BECAUSE IT PERMITS SIMPLICITY**

When operating conditions demand an electrical connector that will stand up under the most rugged requirements, always choose Bendix Scinflex Electrical Connectors. The insert material, an exclusive Bendix development, is one of our contributions to the electrical connector industry. The dielectric strength remains well above requirements within the temperature range of −67°F to +275°F. It makes possible a design increasing resistance to flashover and creepage. It withstands maximum conditions of current and voltage without breakdown. But that is only part of the story. It's also the reason why they are vibration-proof and moisture-proof. So, naturally, it pays to specify Bendix Scinflex Connectors and get this extra protection. Our sales department will be glad to furnish complete information on request.

• Moisture-Proof • Radio Quiet • Single Piece Inserts • Vibration-Proof • Light Weight • High Insulation Resistance • High Resistance to Fuels and Oils • Fungus Resistant • Easy Assembly and Disassembly • Fewer Parts than any other Connector • No additional solder required.

BENDIX SCINFLEX
ELECTRICAL CONNECTORS

Bendix

SCINTILLA MAGNETO DIVISION of SIDNEY, NEW YORK

Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

FACTORY BRANCH OFFICES: 118 E. Providencia Ave., Burbank, Calif. • Stephenson Bldg., 6560 Cass Ave., Detroit 2, Michigan • Brauwer Bldg., 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • 582 Market Street, San Francisco 4, California

Whiz

Specification Corrosion Preventive Compounds
for Government Contractors

Specification Number	Trade Name
MIL-C-972, Grade I (Superseding 52-C-18 Grade I)	Klad Kote 101
MIL-C-972, Grade II (Superseding 52-C-18 Grade II)	Klad Kote 122
MIL-C-6708, Type I (Superseding AN-C-52b Type I)	Klad Kote 102
MIL-C-6708, Type II (Superseding AN-C-52b Type II)	Klad Kote 252
AN-C-124a, Type I	Klad Kote 124
AN-C-124a, Type II	Klad Kote 224
AXS-673, Rev. 2	Klad Kote 103
AXS-1759, Grade I	Klad Kote 171
AXS-1759, Grade II	Klad Kote 172
AAF 14156, Amend. 1	Klad Kote 356
USA 2-122	Klad Kote 322
USA 2-121	Klad Kote 221
AN-VV-C-576b, Type I	Klad Kote 376
AN-VV-C-576b, Type II	Klad Kote 378
Light Bodied Slushing Compound (Excellent Water Displacing and Surface Active Qualities)	Klad Kote 365

PACKAGING ENGINEERS!

Newly Revised Klad Kote Reference Chart Now Available

Our newly revised Klad Kote chart, listing the latest specification numbers and specification requirements, will be sent you upon request. This chart includes the type of film, government specification number, product description, uses, application, removal, flash point, and protection requirements. It is an excellent reference for packaging engineers.

Most Klad Kotes are stocked for prompt delivery and are obtainable in 5 and 55 gallon containers. *Quotations furnished on request.*

Partial List of Specification Compounds Which We Can Supply

Corrosion Preventive Compounds: Navy Dept. 52-C-17 (Int) Amend. 1 (14-C-6) Grades A, B, and C. – U. S. Army 2-84B – U. S. Army 2-82C – Army Air Force AAF 3604-A.
Anti-Seize Compounds: MIL-C-5544 – JAN-A-669.
Aircraft Cleaning Compounds: Army Air Force AAF 20015-E – Navy Aero C-147.
Non-Inflammable Hydraulic Fluid: Navy BuAer MIL-F-7083
Protective Coating: Army Ordnance AXS-1756 – Navy Ordnance 52-C-44.
Paint Remover: Navy BuAer 52-R-15, Amend. 1.
Carbon Removal Compound: Army Air Force AAF X20043-A.

Write: INDUSTRIAL-AVIATION DIVISION

R. M. HOLLINGSHEAD CORPORATION

845 Cooper Street, Camden 2, N. J. Toronto, Ont., Canada

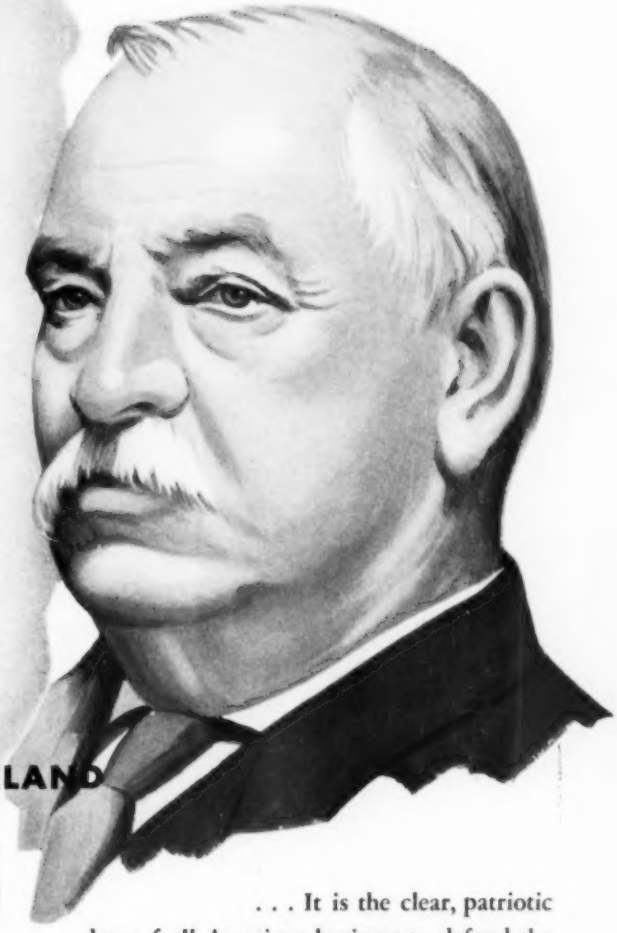
Warehouses:
Dallas San Francisco Chicago

Guide words for today –

"In order that the patriotism and intelligence of the country shall prevail in our legislation, the patriotic and intelligent men of the country must see to it that they are properly represented in our national councils. If they fail in this they will be governed by those who simply make a trade of politics. If it is well that our legislation be influenced by the enlightened and practical business sense of the people, our business men must see to it that those they trust are chosen as their lawmakers. If they are indifferent on the subject the vast interests which so greatly concern them and their fellow citizens will be left at the mercy of those who neither understand nor care for them; and I do not believe these dangers will be effectively averted until they are better understood by the people and more thoroughly resisted."

– GROVER CLEVELAND

address before the Commercial Club of Providence, R. I. June 27, 1891



. . . It is the clear, patriotic duty of all American business to defend the system that made this nation great – and with the same vigor as its detractors.

W B Stuart

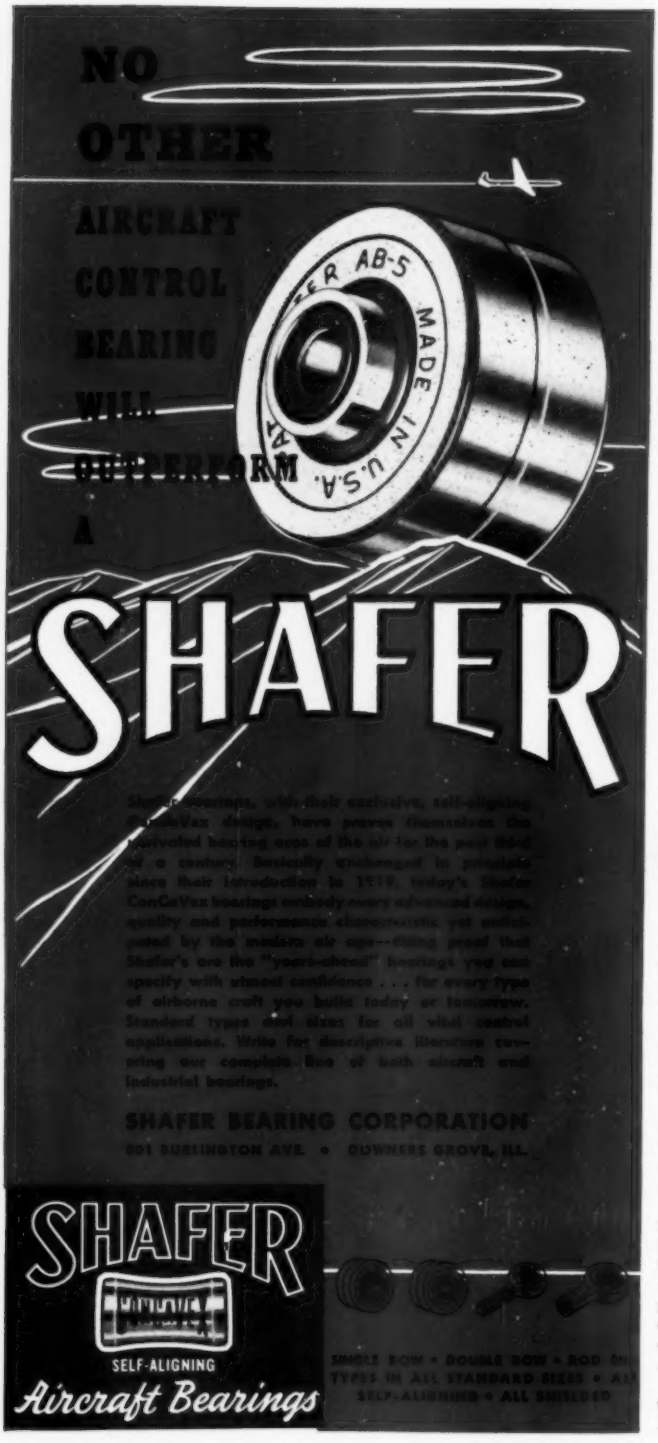
PRESIDENT

DUTY HONOR COUNTRY
LABOR BUSINESS GOVERNMENT

The Gray Manufacturing Company, Hartford, Connecticut

makers of the Audograph Electronic Sounduriter

AND GRAY RESEARCH AND DEVELOPMENT CO., INC., SPECIALISTS IN VIDEO, AUDIO, SUBAUDIO MECHANISMS



ATOMIC ENERGY

NEW U-235 PLANT

The Atomic Energy Commission recently announced the selection of the Goodyear Tire & Rubber Company, of Akron, Ohio, as operating contractor for its uranium-235 production plant soon to be built in Pike County, Ohio, between Portsmouth and Chillicothe.

When the $1,219,000,000 facility is completed some four years hence, the Goodyear Company will be the principal employer there with a permanent working force of about 4,000 persons. In assuming this operation, Goodyear officials will work closely with Union Carbide and Carbon Corporation, operating contractor for the gaseous-diffusion plants at Oak Ridge, Tenn., and Paducah, Ky.

The gaseous-diffusion process, designed to separate fissionable uranium 235 from nonfissionable uranium 238, is one in which uranium hexafluoride in gaseous form is pumped through thousands of extremely fine barriers which have literally millions of tiny holes per square inch. Since U-235 atoms are slightly lighter and therefore travel slightly faster, they strike the screens and pass through the holes with greater frequency than do U-238 atoms. This process gradually separates the U-235 atoms.

The plant will require up to 400,000 kilowatts of power for early operations to be supplied from existing facilities.

AIRCRAFT PROPULSION PROJECT

Construction of facilities related to the eventual development of nuclear propulsion for aircraft has been authorized by the Atomic Energy Commission. Testing facilities will be built at the AEC's National Reactor Testing Station in Idaho. The new facilities are estimated to cost approximately $33,000,000. During the peak of construction, about 1,000 workers will be employed and about 200 employees will be required for operations.

Preliminary design studies for the AEC ground test station were performed by the Parsons-Macco-Kiewit Company of Los Angeles, Calif., under a subcontract with General Electric Company.

The design, development, and fabrication of the prototype aircraft propulsion reactor are being done by the Aircraft Gas Turbine Department of General Electric at Lockland, Ohio. The nuclear phases of the project parallel the associated nonnuclear propulsion devices being developed by General Electric under an Air Force contract.

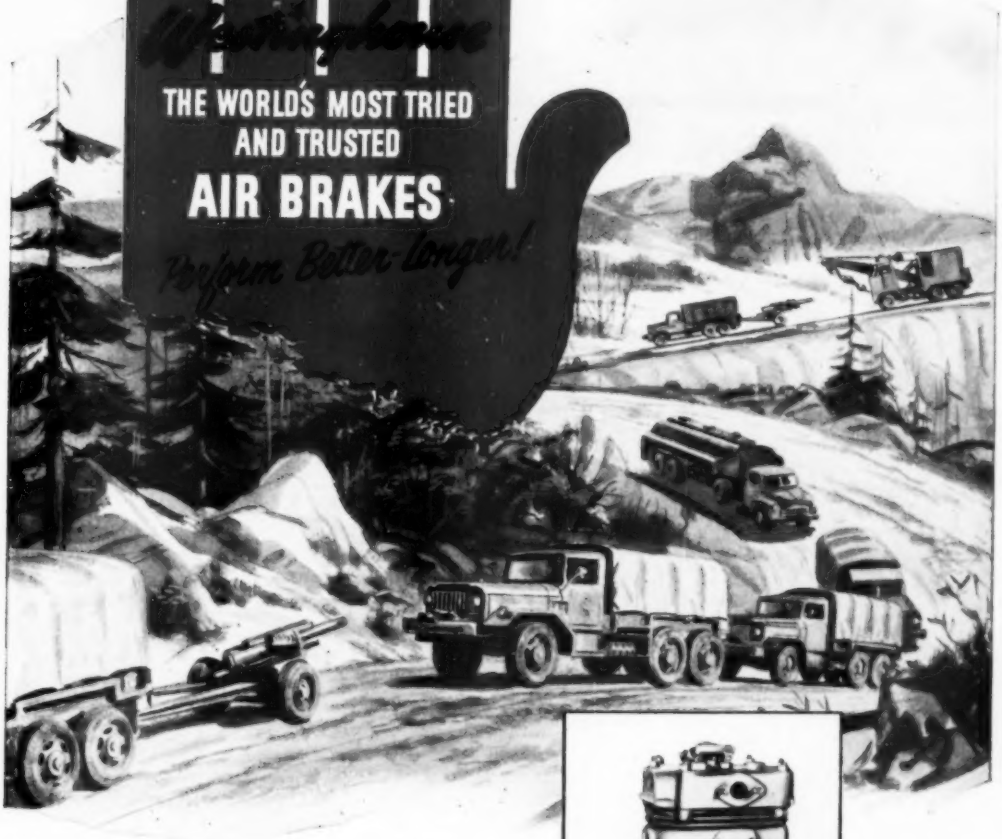
Design and construction of the ground test facilities will be administered by the AEC's Idaho Operations Office. The Chi-

Bendix-Westinghouse

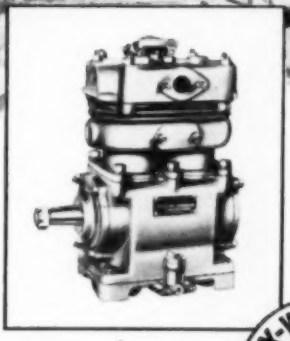
THE WORLD'S MOST TRIED AND TRUSTED

AIR BRAKES

Perform Better-Longer!



Over the treacherous mountain stretches of Korea . . . on the rugged, icy avenues of the arctic . . . through the steamy, swampy trails of the tropics, Bendix-Westinghouse Air Brakes have demonstrated a matchless ability for rugged, reliable performance on Ordnance vehicles in service the world over. That's because these mighty brakes are built for long life dependability and powerful performance while requiring little maintenance under even the most grueling operating conditions. The Bendix-Westinghouse compressor for example, designed on the same reciprocating piston principle as the standard truck engine, has proved its remarkable durability time after time by often *outlasting* the life of the vehicle itself. Take advantage of it—when you specify air brakes don't settle for a second choice—specify Bendix-Westinghouse, the world's most tried and trusted air brakes.



The Bendix-Westinghouse Compressor—heart of the air brake system—performance proven over more miles on more installations than any other compressor.

BENDIX-WESTINGHOUSE AIR BRAKES

REG. U. S. PAT. OFF.

BENDIX-WESTINGHOUSE AUTOMOTIVE AIR BRAKE COMPANY • ELYRIA, OHIO

OPERATION UNIVERSE

Exploring the unknown through sky-riding rockets guided by "electronic brains" . . . intricate instrument assemblies which set, control and record the course of the missile. Ultimate performance from electrons to space traveling warheads is obtained through mass produced and precision made magnetic alloy components.

MAGNETIC METALS COMPANY

Soft Iron and Alloy Cores and Shields

E MASS PRODUCED PRECISION MADE

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Camden 1, N. J.

OFFICIAL U.S. NAVY PHOTO

cago Operations Office will continue to have responsibility for the reactor development contract with General Electric. Support in nuclear design and development also is being furnished by the Oak Ridge National Laboratory.

URANIUM FROM PHOSPHATE

The first commercial unit for the recovery of uranium from phosphate rock has begun operation as a part of the plant of the Blockson Chemical Company near Joliet, Ill.

Research, engineering, and construction of the unit were accomplished by the Blockson Chemical Company, which has a contract to supply the recovered uranium to the Atomic Energy Commission.

Uranium occurs as a very minor component of the extensive phosphate deposits of Florida and several Western states. Studies sponsored by the AEC have established the feasibility of recovering these small quantities of uranium as part of the process of manufacturing sodium phosphate chemicals and concentrated commercial fertilizers.

The uranium recovery facilities will be operated in conjunction with the Blockson Company's existing plant for the production of phosphate chemicals near Joliet. Phosphate rock from Florida is used in the plant.

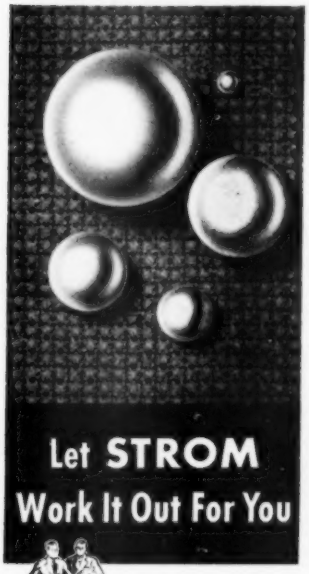
Several other processors of phosphate rock have conducted research and pilot-plant studies in the field of uranium recovery, and three companies are building full-scale recovery units. The International Minerals and Chemical Corporation and the Virginia-Carolina Chemical Corporation are incorporating uranium-recovery units into plants now under construction near Mulberry, Fla., and Texas City Chemicals, Inc., is building a recovery unit at Texas City, Tex.

AEC OFFICE ESTABLISHED

A San Francisco Operations Office of the Atomic Energy Commission has recently been established, bringing to nine the number of AEC's principal field administrative centers. The San Francisco Area Office, which has been reporting directly to the AEC Production Division in Washington, and the Berkeley Area Office, which has been under the Chicago Operations Office, are consolidated into the new operations office, reporting directly to the director of the Reactor Development Division.

The San Francisco Operations Office will be responsible for administration of contracts with the University of California for operation of the Radiation Laboratory at Berkeley; the California Research and Development Company for operation of facilities at Livermore, Calif.; North American Aviation, Inc., for de-

a metal ball PROBLEM?



Whether it is a precision ball bearing or one of the other many ball applications in industry, your problem will not be entirely new. Strom has been in on many ball problems and knows the importance of the right ball for the job.

Strom has been making precision metal balls for over 25 years for all industry and can be a big help to you in selecting the right ball for any of your requirements. In size and spherical accuracy, perfection of surface, uniformity, and dependable physical quality, there's not a better ball made.

Strom
STEEL BALL CO.
1850 So. 54th Ave., Cicero 50, Ill.
Largest Independent and Exclusive Metal Ball Manufacturer

WE MIGHT SAY SORRY!

BUT YES MEANS IT WAS WELL WORTH THE TIME YOU TOOK TO ASK ABOUT . . .

O & S BEARINGS and BUSHINGS
NON-METALLIC – SELF-LUBRICATING
. . . FOR THOSE PARTS THAT OSCILLATE, ROTATE OR SLIDE AND ARE DIFFICULT OR IMPOSSIBLE TO LUBRICATE!

The manufacturing skill and engineering experience gained by O & S in producing original automotive parts for the past 38 years is well worth your investigation.

If your problem involves a movement in a mechanical part or a combination of parts requiring trouble free, service free bearings or bushings, send us the details or write for Bulletin 251.

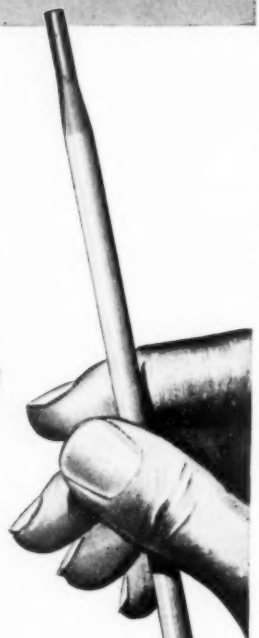
NeverOil · SINCE 1913 ·
O & S BEARING CO.
303 SOUTH LIVERNOIS · DETROIT 7, MICHIGAN

an ACCO product

Stainless Steel WELDING ELECTRODES

AC or DC
made by
PAGE
for
Armor Welding

the BEST
for any weld . . .
on all types
of stainless steel



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velopmental work being conducted at Downey, Calif.; and for other research and development contracts in the West Coast area.

POLONIUM NOW AVAILABLE

Reactor-produced radioactive polonium-210 may now be purchased at Oak Ridge for research activities. Polonium is the first reactor-produced radioisotope to be sold which emits alpha particles. It can be used also as a source of high-energy neutrons.

The Isotopes Division, a part of the AEC's Oak Ridge operations, and the U.S. licensing agency for purchases of significant quantities of radioactive materials, said the newly available polonium is needed by research groups for physical and biological investigations. It may be used also in oil-well logging.

In addition, the element could be used in luminous phosphors, static-elimination devices, and for other industrial purposes. However, it is not available at present in the quantities required for such uses.

Polonium can be bought at Oak Ridge National Laboratory in two forms. When it is to be used as a neutron source, the polonium will be mixed with beryllium and enclosed in a cylinder of nickel, about ¾-inch in diameter. As an alpha source, the polonium will be plated on a strip of platinum.

Polonium-210 produced in a reactor by neutron bombardment of bismuth is of higher purity than polonium derived from the radioactive decay of radium.

Operated for the AEC by Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation, Oak Ridge National Laboratory is the site of the X-10 graphite-uranium reactor, or pile, in which most commercially available radioactive isotopes are produced. ORNL also produces and ships stable isotopes to licensed purchasers.

The demand for isotopes, distributed under a pricing system intended to cover production costs, has risen at a steady rate each year. No indication of leveling off is apparent in year-to-year figures on shipments. Shipments for fiscal year 1952 totaled some 9,000—about 25 per cent of shipments in the entire 6 years of the program.

The medical field, using isotopes in research and therapy, has taken some 13,000 shipments in 6 years, more than twice the number received by isotope users in the field of animal physiology, the second greatest field of isotope usage.

Next, in order of number of shipments: physics and chemistry, general research and development, industrial research, plant physiology, and miscellaneous, including commercial processors who resell the materials they buy.

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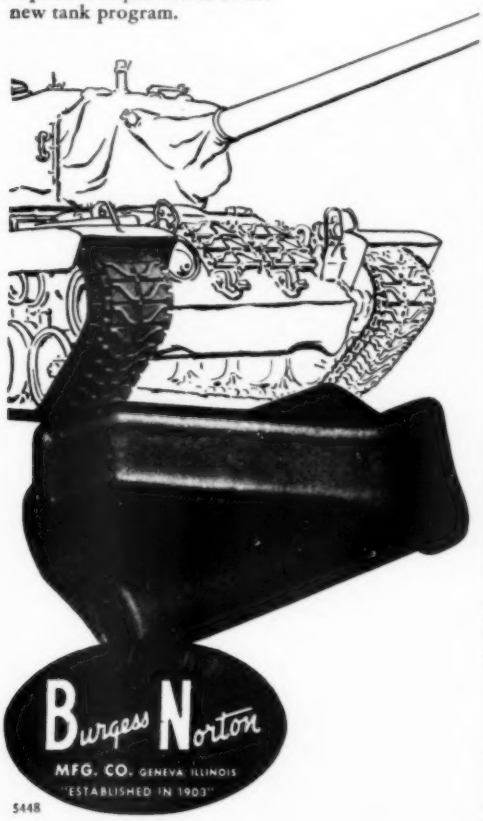

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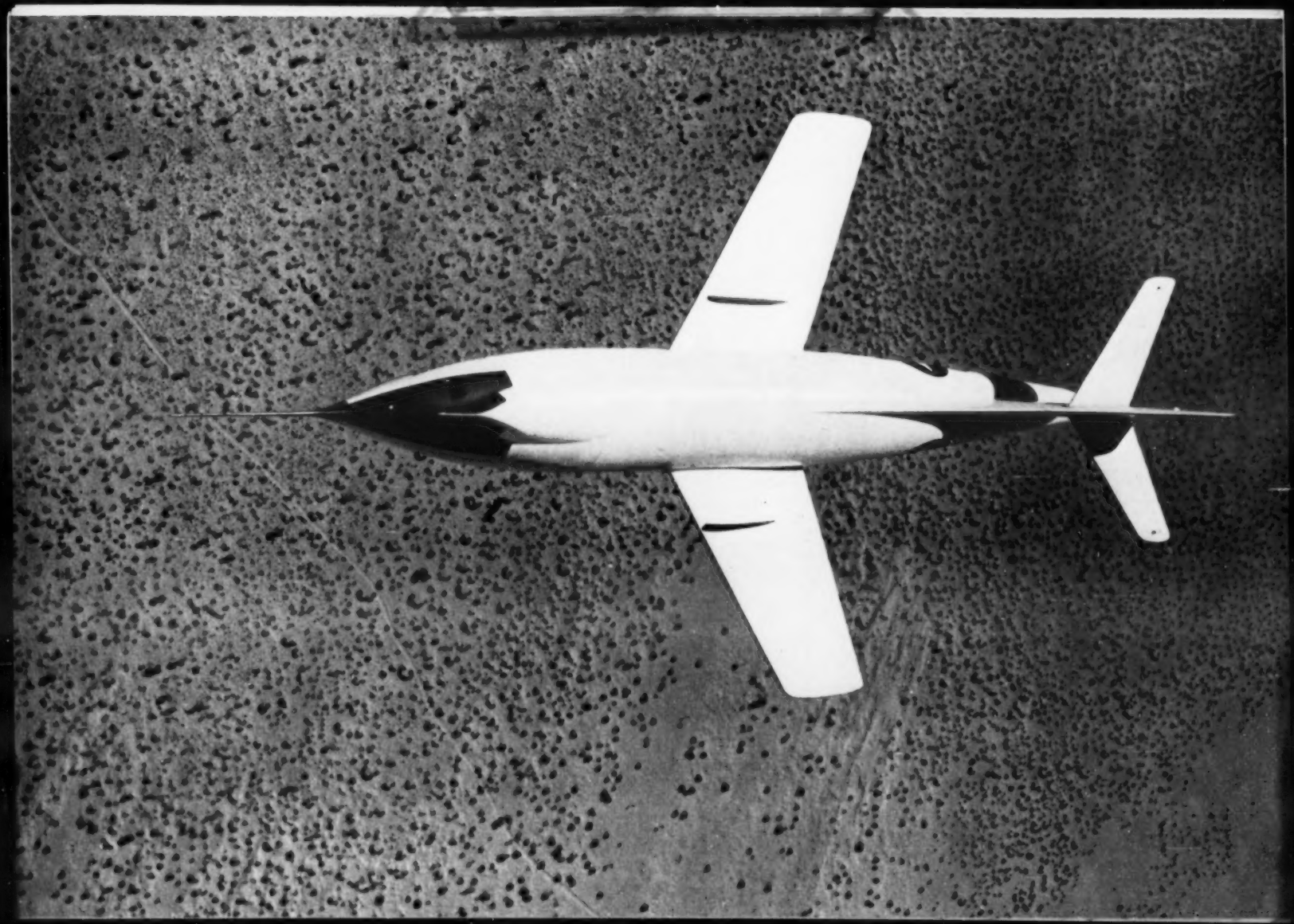


America's Munitions, 1953

Our Guns-and-Butter Program Means New Responsibilities

ROBERT A. LOVETT, Secretary of Defense, recently issued a new Munitions Board charter which greatly strengthens the authority of the Board Chairman and more clearly defines the authority and duties of the Board and its staff.

Power of Decision

The charter takes the place of a similar directive issued in 1949 and amended the following year. Under the new charter, the Board Chairman, John D. Small, will have the power of decision upon all matters falling within the jurisdiction of the Board. Under the previous charter, the Chairman decided only when Board members were divided in their views.

The new charter broadens the area of Board jurisdiction. It emphasizes the Board's primary functions in the fields of production, procurement, distribution, real property, and construction.

It also directs that the Board, within these broad fields, shall make policy and shall take all actions necessary to see to it that there is compliance with such policies.

The Chairman of the Munitions Board is the principal adviser and assistant to the Secretary of Defense in supply management and industrial matters. The Chairman is further authorized to:

1. Take action on any matters which, because of the exigencies of time, do not permit formal Board action.

2. Perform all detailed actions necessary to discharge the Board's duties.

3. Perform all duties which have been or may be assigned specifically to him individually by the Secretary of Defense.

4. Perform any of his duties through or with the aid of such members or officials of the Board as he may designate.

5. Establish such continuing or temporary committees, councils, or agencies as may be necessary to conduct studies, assemble information, make recommendations, and otherwise assist in the carrying out of the responsibilities of the Board under his authority, direction, and control.

6. Issue directives in the name of the Board or in the name of the Secretary of Defense as may be appropriate.

7. Prepare policies, plans, and programs for presentation to the Board.

8. Represent or arrange for representation of the Department of Defense before and with other governmental departments and agencies on all matters for which the Board or the Chairman has responsibilities.

9. Make appropriate recommendations to the Secretary of Defense for improvement in supply management and industrial matters.

John Davis Small, Chairman of the Munitions Board, whose photograph appears on the front cover of this issue, has had wide experience both in business and government.

During World War II he was on active duty with the Navy, serving as deputy director of the Army-Navy Munitions Board and as executive officer of the War Production Board. Prior to his present appointment he was vice-president and executive assistant to the president of the Emerson Radio and Phonograph Corporation.

Mr. Small was born in Texas in 1893 and was graduated from the U. S. Naval Academy in 1915. During World War I he served aboard a destroyer operating with the Atlantic Fleet. In the following decade he served aboard several destroyers, qualified as a submarine officer, and obtained his naval-aviator rating.

From 1926 to 1941 Mr. Small was associated with private industry. Called to active duty with the Navy in 1942, he was appointed deputy director of the Army-Navy Munitions Board, headed the Navy Material and Products Control Division, and then became landing-craft coordinator with the first Allied troops to land on the Normandy beaches on D-Day.

In 1944 he became executive officer of the War Production Board and was awarded the Legion of Merit for outstanding services in the reorganization of the Navy's production program and in the development of the Controlled Materials Plan.

Mr. Small was appointed Chairman of the Munitions Board by the President on November 10, 1950.

Composition of Board

In addition to the civilian Chairman, appointed by the President, the Munitions Board is composed of an Under or Assistant Secretary from each of the military departments.

It is subject to the authority and direction of the Secretary of Defense and functions in consonance with strategic and logistic guidance provided by the Joint Chiefs of Staff.

Under the new charter the Munitions Board has great responsibilities and broad powers. Mr. Small is exceptionally well qualified to use his authority to increase efficiency and economy in the defense services.

His early service with the Navy, both afloat and aloft, gave him the fighting man's viewpoint on the need for the best combat equipment, enough and on time, and his World War II service gave him further insight into the logistical problems of national defense.

SUPERSONIC FLIGHT *research is the object of the Douglas designed and built Navy Skyrocket airplane. It is powered by dual rocket and jet engines.*

Scale model Douglas Skyrocket ready for stability tests at Langley Aëronautical Laboratory of the National Advisory Committee for Aëronautics.

Flying Laboratories

Special High-Speed Test Planes Compile Vital Aëronautical Data

Walter T. Bonney

Assistant to the Executive Secretary, National Advisory Committee for Aëronautics

IN August of last year, Bill Bridgeman, Douglas Aircraft Company's test pilot, made two historic flights in the D-558-III Skyrocket airplane designed and built by his company. On August 7th, he flew higher than man had ever gone before. Eight days later, he flew faster than man had ever traveled.

The altitude mark was 79,494 feet. The speed was 1,238 miles an hour—15 miles high; almost twice the speed of sound!

Figures Confirmed

Both figures were confirmed by the Navy this summer, the speed mark being announced by Secretary of the Navy Kimball on July 15th at Los Angeles.

These are the obvious, the spectacular peak accomplishments of the high-speed research airplane program which the United States has been vigorously pushing since the years of World War II to keep our Nation out front in the inexorable race for air supremacy. Cooperating in this continuing program have been the Air Force, the Navy, the aircraft industry, and the National Advisory Committee for Aëronautics (NACA)—the Nation's aëronautical research establishment.

The program has been costly, the expense being counted in millions. But it is a program that is paying off, handsomely. Tomorrow's airplanes, the ones now being readied for the flight lines and still on the drafting boards, reflect in many ways new aërodynamic knowledge gained from the program, although because of security comparatively little can be said about that new information.

Skyrocket and Skystreak

To attempt to tell the high-speed research airplane story from the beginning, outlining in detail the use of each of the several special airplanes, would require far more space than is presently available. Rather, after a brief summary of the reasons for such an undertaking, it is proposed to limit this account to the Skyrocket and its sister, the Skystreak, as representative of the larger narrative.

On the eve of World War II an aëronautical revolution was in the making. In Germany and England long-known theories of jet propulsion were being hammered into practical engine design. Here in the United States, too, aëronautical development was in high gear. Tactical airplanes capable of 400-mile-an-hour speeds were demanded by the military services.

Many Busy Minds

At the NACA's Langley Aëronautical Laboratory, many minds were busy on the problem of how to accomplish such goals. And in the country's aircraft factories, designers were just as busy, seeking to shape aircraft sufficiently sleek and strong to hit the magic 400-mile-an-hour mark, using the 1,000-horsepower power plants available.

Techniques Lacking

One of the outgrowths of this period was realization that laboratory techniques just didn't exist to permit projecting aërodynamic research deep into the speed region where compressibility existed. (In later years, "compressibility" would be heard less frequently as "critical Mach number" came into general use.) But whether laboratory techniques were available or not, compressibility became a problem of increasing concern as pilots in their new, faster fighters came face to face with

The Convair XF-92, above, is prepared for tests in the 40x 80-foot wind tunnel at Ames Aëronautical Laboratory, Calif.

A technician, above, mans the ground radar mechanism used to track the research airplanes during test flights.

this serious, but little-known phenomenon.

The pilot's first warnings of trouble were a large increase in the force required to move the airplane's elevators and a nose-down change in trim that tended to increase the angle of his dive. These warnings developed only after the stability and control characteristics of the airplane had deteriorated to a point where recovery from the dive was difficult if not impossible.

Initial Impetus

It was this urgent need for aërodynamic information, especially in the transsonic region where air flow is mixed, part slower and part faster than the speed of sound, which provided the initial impetus for an audacious project that envisioned use of full-scale, specially designed airplanes to secure the information required.

With either turbojet or rocket engines these research airplanes would have sufficient power to permit the maximum speed aërodynamically possible to be reached in level, or even climbing, flight. This would obviate the danger which occurred whenever a pilot pushed a conventional plane into the dive necessary to reach speeds where compressibility would take place.

Equally important, such research airplanes could be made as strong as desired. And common sense demanded they be flown at the highest possible altitudes, where loads expected as the transsonic speed range was penetrated would be the lightest.

But the paramount job at hand was designing and building aircraft to win World War II. All but a trifling amount of the research effort at the NACA laboratories was devoted to learning the quick-fix answers which would make right-then airplanes fly better and faster and farther.

By 1943 that task seemed well along, and before the year ended the need for new aërodynamic information in the transsonic range had become so obvious that the Navy, Air Force, and NACA held conferences to explore the idea of special research airplanes to probe the transsonic speed region. In 1944 the ferment of new ideas continued, and decisions were made to go ahead with such a program.

At first, two projects were planned. One was to be a rocket-powered airplane sponsored by the Air Force and manufactured by Bell Aircraft Corporation. This was the X-1 which, on October 14, 1947, with then Capt. Charles E. Yeager at the controls, became the first airplane to fly faster than sound. In this undertaking, as with the other aspects of the program, the NACA was an active partner.

Longer Flight

The second research airplane was to be powered by a turbojet engine and was to be one which would fly for a longer period than the X-1, thus permitting detailed flight studies in the high subsonic range. This airplane was sponsored by the Navy, and the Douglas Aircraft Company was invited to design and construct the D-588 Skystreak.

Later, of course, there were other high-speed research aircraft ordered—the Phase II Douglas D-558 (Skyrocket); the Bell X-2; the Douglas X-3; the Northrop X-4; the Bell X-5; the Consolidated XF-92-A. Of these the X-2 and X-3 have yet to fly; the others have been used to develop important aërodynamic information.

The reason the Navy D-558 project became two airplanes, the Skystreak

and the Skyrocket, was to broaden the scope of the program to include flight investigation of swept-wing airplanes. In the United States, theoretical work had been done which led to the concept that compressibility troubles could be delayed or minimized by use of sharply swept wings. After V-E Day, it was learned that even earlier the Germans had explored the advantages to be obtained from the use of wing sweep.

Two Designs Adopted

It was in the summer of 1945, during mock-up board conferences at the El Segundo Division of Douglas, that the decision was made to go ahead with two designs. The original D-558, the Skystreak, was to have straight wings and a General Electric TG-180 engine. It was not designed for tactical use but as a research tool. It was to be used principally for aërodynamic exploration in the lower transsonic range (speeds between 75 to 90 per cent of the speed of sound).

General agreement on the Skystreak design among the Navy, Douglas, and the NACA was reached in December 1944; final agreement came in July 1945; and construction was completed twenty-three months later.

When a second D-558 (Skyrocket) was authorized, it was specified that swept wings should be incorporated and that, in addition to a Westinghouse J-34 turbojet engine, it should be equipped with a Reaction Motors rocket engine for additional thrust. Because so little was known then about wing sweep except that lift would be reduced, the degree was finally cut back from a hopeful 45 to 40, and finally to 35.

By the summer of 1947 the brilliant red Skystreak had been test-flown by Gene May of Douglas, and the results were so successful that during low-level flights over Rodgers Dry Lake in the Mohave Desert (formerly known as Muroc, now the site of Edwards Air Force Base) a new speed record of 650.6 m.p.h. was established.

Three of the Skystreaks were built; one was destroyed on take-off in May 1948 due to mechanical failure. One of the two remaining airplanes, despite the fact that its top speed is definitely subsonic, is still being flown by NACA pilots and producing useful information in the lower transsonic range.

Structurally, the Skyrocket is quite similar to the Phase I D-558. Magnesium alloy has been used for more of the fuselage skin, while 75 S aluminum alloy is largely used for the wing and tail surfaces. Leading-edge automatic slots and wing fences are provided to overcome some disadvantages of the conventional subsonic-airfoil swept wing used.

Heavy Instrument Load

The Skyrocket, like its earlier sister, was designed to take off, fly, and land under its own power. Similarly, it was to carry 500 pounds of instrumentation provided by the NACA.

Originally planned for flight research at altitudes only moderately higher than the Skystreak, it was expected that the Phase II Skyrocket would be used mostly in a speed range from 85 per cent of to, say 1.15 times the speed of sound. But it became apparent that if the duration of the rocket engine could be extended the flight investigations could be projected to higher speeds and altitudes.

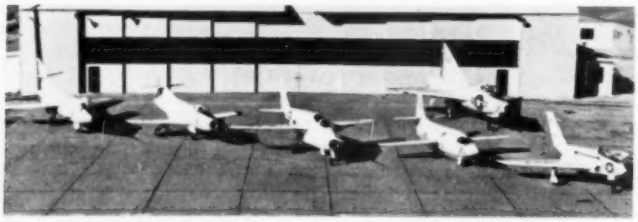
In readying the Skyrocket for higher-speed research, the jet engine was removed and larger liquid-oxygen and alcohol fuel tanks installed. The air-launch system, which Bell had pioneered, was adopted. Using a Boeing Superfortress as a mother ship, the research airplane was carried to altitudes of 25,000 feet or higher before release. From the standpoint of safety, and also fuel economy, it was a sound decision.

Pilot of the airplane during the flights higher and faster than man had ever gone was Bill Bridgeman, who was a member of the fabulous Miller's Reluctant Raiders during his Navy days. Highly regarded for his competence, Bridgeman stirred up some excitement late last year when he referred to the Skyrocket as an obsolete aircraft, and then went on to tell about some of the control troubles he had had as his airplane hurtled through the skies at speeds approaching twice that of sound. He mentioned violent rolls with the wings dipping as much as 75 degrees on a side at a rate of 86 degrees a second.

Later, the phenomenon he described was described in the press as "supersonic yaw" and termed a "new peril of the sky." But, actually, Bridgeman's comments about the Skyrocket shouldn't be too startling or worrisome. After all, the airplane was designed at a time when high subsonic flight was all that any one had attained or knew very much about. The airfoil sections were conventional subsonic, with rounded edges and contours. If the Skyrocket showed unpleasant wallowing characteristics as it flew, gathering aërodynamic information that would be most helpful in the design of tomorrow's fighters, so what! No one had ever expected the Skyrocket to be a fighter, at least not very seriously.

Instrumentation

Instrumentation, one might say, holds the key to whether the flights high and fast in the sky will produce information that is really useful—instrumentation, carefully developed after years of effort, the result of repeated failures and new attempts; instrumentation, the mass of it from the instru-



Above. NACA's team of research aircraft lines up at Moffett Field, Calif. Left to right: D-558-II, D-558-I, X-5, X-1, X-4, and, rear, XF-92-A.

ment shops at the Langley Laboratory; telemetering equipment, pressure-measuring devices, load-recording machines, and all the rest.

Reduction of Data

And then, of course, comes reduction of the raw data gained from flight. Computers to make the calculations; aërodynamicists to ponder the figures and determine what they mean. Behind all the activity at Edwards Air Force Base, where the NACA maintains a tight organization of competent specialists now numbering nearly 200, behind the planning around the long conference tables, even behind the design and manufacture of the research airplanes themselves are the patient men whose responsibility it is to fit the full-scale flight work into the larger research pattern, to see to it that the investigations in the laboratories and the investigations in the skies complement rather than compete with one another.

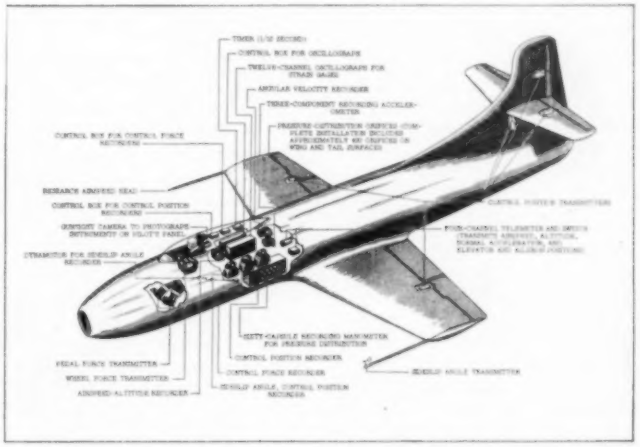
Paradoxically, although the original concept of the high-speed, full-scale research airplane program was to obtain information about aërodynamic behavior in the transsonic region because such data could not be produced in existing laboratory facilities, the same laboratory facilities were extensively used to point the way and to suggest probable answers to problems arising during design of the research airplanes themselves. At all NACA's laboratories —Langley in Virginia, Ames at Moffett Field, Calif., and Lewis in Cleveland—this work was intensively pursued.

Research Still Needed

Seven years ago, transsonic research in wind tunnels was impossible because of "choking." That was an impelling reason, all by itself, for the high-speed research-airplane program. For the past year or longer there have been transsonic wind tunnels with what the engineers call "ventilated throats." But does this mean there will be no need for further full-scale, high-speed research? Not at all, the engineers say.

In the laboratories, conditions can be isolated and studied with a precision which is extremely valuable. But only in flight itself can the problems be studied as a whole. Not only that, but problems related to loads, dynamics, and operation can best be attacked by flight tests with full-scale airplanes.

So, in the last analysis, the high-speed airplane represents another of the sharp tools which the researcher needs in carving out the building blocks of new information so essential to the design of tomorrow's aircraft. Although most of the benefits from the program still must remain classified, the following gains may be cited:



Drawing, above, shows NACA research instrumentation in the D-558-I Skystreak.

Difficulties Defined

1. Stability difficulties encountered as an airplane passes through the transsonic speed range have been thoroughly defined. In essence, what has been learned, the information gained in flight, has confirmed "trend data" produced in the laboratories. From this work has come gratifying progress toward development of ways to eliminate or minimize the stability difficulties encountered.

2. Prime information concerning full-scale aërodynamic loads so necessary for the precise design of structures for high-speed airplanes has been forthcoming. Prior to availability of this information, designers were forced to gamble on the basis of incomplete data. Either they could beef up a structure to the point where performance suffered, so as to avoid possible failures, or they could shave margins of safety.

3. A goodly number of pilots have been trained in the business of going through the "sonic barrier." They have learned there is no special trick, no special danger. Their experience makes relatively easy the training of tomorrow's service pilots to do the same thing in military airplanes on tactical missions. Stated another way, the repeated supersonic flights of the D-558-II and the X-1 have eliminated the psychological block which existed in the minds of most pilots—the fear that supersonic flight was extremely difficult, requiring the talents of a superman.

4. From qualitative and quantitative study of how the research airplanes behave in maneuvers, the first real, basic information about how well the supersonic airplane will serve as a gun platform has been obtained.

5. In the engine field, work on the design of supersonic inlets is being accelerated as a result of the program, and the matter of fuel consumption at supersonic speed is being evaluated. From this work the problems are being understood of future long-range carriage of high-class goods, like passengers, at supersonic speeds. Present indications are that the prospects are good for such developments, requiring only further research.

Freedom of Action in War

Military Flexibility Is Necessary for Final Victory

by

Rear Adm. Edward A. Mitchell

U.S. Navy, Retired

"Flexibility which gives freedom of action, and freedom of action which gives flexibility, don't just stumble into the military tool kit. They are placed there only by properly directed effort."

IN war things don't just happen. They occur because of many human decisions made in the ranks of both adversaries. It is freedom of action to make such human decisions effective that produces the variety of circumstance which must be met in war. It is curtailment of such freedom of action that produces the reality of circumstance which cannot be met in war.

Purpose of War

War is an effort, principally made and opposed by force of arms, in order to be able to impose the policies of certain humans on certain other humans. When carried through to a decision, the loser is forced to acquiesce in whatever the winner undertakes to enforce. Thus, war seeks a political objective set by human beings, for good or evil depending upon the point of view. However, international acts of aggression which go unopposed can produce accomplishments otherwise attainable only through success in war.

If we do not oppose such acts there is no war. Eventually the relative situation may change beyond reasonable chance of our abilities *ever* to take appropriate counteraction with success.

Vital to proper understanding is the fact that a decision which restrains the use of opposing force or terminates such enemy use of force already begun is made by appropriate enemy authority or by replacement of such enemy authority by the authority of our own armed force or by some alien authority amenable to our wishes.

It is this decision, made by the enemy himself, or made for the enemy through the fact of our armed authority in appropriate control of the situation, that alone makes possible the attainment of our political objectives by war. Hence, bringing this about is the basic task which our total military effort must finally accomplish.

All our military action is to place or to maintain our political authority in control of the situation so that it may attain its "political objectives" in all respects. Each partial victory must be followed up if decisive final victory is to follow.

What are the pressures on enemy humans in authority which we must create? Basically they are two: (1) the pressure of scarcity through destruction, blockade, and capture of the enemy's material means to exist and his material means to resist, wherever and in whatever form they can be found and attacked; and (2) the pressure of fear through the apparent hopelessness of the strategic situation.

Admiral Mitchell was graduated from the U.S. Naval Academy in 1917. He served on the staff of the Naval War College, and during World War II was operations officer and senior planner for the amphibious invasions of French Morocco and Sicily. He was assistant chief of staff for plans under Admiral Kirk at the invasion of Normandy, and commanded the cruiser SALT LAKE CITY at Iwo Jima and Okinawa. Admiral Mitchell was also a member of the Inter-American Defense Board.

It is essential to appreciate that both are necessary and, in fact, complementary and interdependent. For, as scarcity of enemy supplies ultimately mounts to ease the task of our strategic advance, so appropriate strategic advance extends the effectiveness of our blockade.

Need Suitable Tool

War is also a business of creating the effect desired by the commander, on any level, in order to accomplish his immediate task in hand. He is the carpenter who must select the tool and use it. It is just as essential that the tool be suitable to create the effect he desires as it is that the effect he desires to create be suitable to accomplish his own assigned task.

But "suitable" means suitable at the time and place of action, in the circumstances of availability, capability, geography, and relative position with respect to both adversaries.

Perhaps the most widely known method of creating scarcity among the enemy in war is that of naval blockade and trade warfare. Less well appreciated is the fact that so-called "strategic" bombing is but a logical application of the power of flight to accomplish the ageless objective of blockade by ability to reach targets hitherto inaccessible.

Blockade Effect

Thus it is immaterial whether enemy economic and military resources are eliminated by torpedo, mine, gunfire, bomb, or sabotage, or whether they pass behind the lines of our strategic advance. It is all blockade effect. To call it otherwise is to deny that there be unity of blockade effort.

Without the flexibility of armed force geared for both strategic advance and blockade there is no freedom of action to conduct an offensive. In fact, even though hitting back, one is on the defensive in reality. The defensive, necessary though it be at times in cer-

tain places, does not win wars. It may not even stave off defeat.

Amphibious capability in the seapower compartment has given freedom of action to deploy land and air power across the seas into strategic areas of decisive contact with enemy land power and industrial might. Unhampered, sea power is ever ready to use the navigable waters of the world to solve stalemate by envelopment wherever the sea permits, to enable land power to cut vital enemy communications, or to choose a more direct strategic route for land campaigning.

It is qualified to divert opposing forces out of all proportion, merely by the uncertainty as to where it will strike next, since it can strike next wherever there are navigable waters. It is prepared to plant air power where geography permits its numbers to apply such continuity of pressure that the percentage of hits may give adequate result.

Fighting Abroad

Freedom of action is, to us, the privilege of doing our fighting in some one else's back yard. It is not without reason that after two world wars our United States has had no cities laid in ruins by enemy action. Geography alone is not responsible, for, although the ocean is by nature a pathway for those equipped to use it, wars are not won by lost opportunities.

Loss of the initiative can be disastrous in war. Great cost in time and effort and lives is the usual price we pay to produce the freedom of action of favorable circumstance required to get it back.

The selected strategy of any commander is his chosen line of endeavor, designed to bring about the effect desired from his alloted part in the plans of his immediate superior. Thus it is essential that all forces, by their respective operations, must serve directly or indirectly the selected strategy of their common commander. Otherwise, they may absorb effort which we can ill afford to squander or for the want of which our main effort may fail.

It is in the nature of war in all its stages that much indirect effort must be expended to insure the success of our ultimate line of endeavor. At times it is even essential to the latter's being undertaken at all. Some examples of this indirect effort are: the effort that goes into gaining and denying information, providing for security, improvement of faulty geographical position, providing logistic supply and the replenishment of the combat forces, and the build-up of adequate and suitable force.

Because such operations are indirect in their effect in no way alters the fact that they must give freedom of action to pursue the selected strategy and therefore are equally "strategic" in their nature. For if they do not serve the strategy they are so much wasted effort.

Effectual strategic plans for major war naturally envision the creation of a favorable military situation calculated to enable us to impose our will on the appropriate enemy authority or to supplant such enemy authority in appropriate control if need be.

Sound concept is necessary concerning the stages by which the favorable military situation is to be brought about. If the strategic plan is to be executed with each service contributing its alloted share in true unity of effort from the start, it is necessary to equalize any unbalance in the available peacetime forces of any service.

Sound Demand

Thus when budgeted only by the judgment that comes from service experience the planners create a sound and scheduled demand for forces which are suitable to produce decisive victory.

Circumstances alter cases, and the circumstances of war are no exception. Flexibility which gives freedom of action, and freedom of action which gives flexibility, don't just stumble into the military tool kit. They are placed there only by properly directed effort.

It is the duty of strategic preparation, in so far as possible circumstances can be foreseen, to give the responsible commanders in the field adequate flexibility in authority, in organization, and in material means. Only in this way will the commander have adequate freedom of action to meet the circumstances of the time, taking advantage of some and overcoming the remainder.

Wisdom Required

Of these three bases for flexibility and freedom of action, only the last, provision of the appropriate means, costs money. The price of the other two, authority and organization, is wisdom in the form of sound military concept, effective during the preceding peace so as not to fetter the freedom of action of the responsible commanders on the day of reckoning.

Wisdom, too, is the initial down payment on provision of the appropriate means. Wisdom is needed to unloosen suitable lines of industrial effort which age not speedily reoriented in this highly technological age. Wisdom is needed for sound concept concerning both the factual capabilities and limitations of land, sea, and air power, alone and in appropriate combination.

Most important of all, unfettered by artificial prescription concerning what may and may not be allowed, wisdom is needed which is neither chained to the past *per se*, nor wedded to change for change's sake alone. Thus are the lessons of the past made to serve the future and true principles preserved, while pithy sayings and half-truths are prevented from masquerading as principles.

Dunkerque was a tragedy in more ways than one. The "Battle of Britain" and the immediate post-Pearl Harbor highlights have eclipsed the lack of tangible results achieved before the invasions of Guadalcanal and Northwest Africa started the march which led to final victory. Forgotten, too, is the relentless pressure of sea power, threatened though it was by the German submarine.

Sea power prevented further loss of

The opinions and assertions expressed in this article are those of the writer and are not to be construed as official or as those of the Navy Department or of the Naval Service at large.

a vital geographical position, such as Britain, which even the mighty German Luftwaffe failed to conquer by "strategic" bombing or by an assist of major proportions by the German submarines.

Not in America

The war was fought in Europe, Africa, Asia, and in the vast Pacific—but not in America. Such was the flexibility and freedom of action given by the capability to conduct the "profligate land-and-sea strategy" of the recent past.

But Dunkerque had its lessons for the Germans, too—lessons they could never take advantage of because it was already too late for them to reorient. The Wehrmacht lacked flexibility in the sea power compartment of its toolbox, from which amphibious power was lacking. Freedom of action was not theirs to turn the obstacle of the English Channel into a German highway and change the course of history.

Such was the price of prescripted naval development for which a land-minded German General Staff must share the blame. Such are the results of allowing other-service lack of experience to interfere with own-service capabilities.

Neither an air force nor a navy nor an army can be a jack of all trades. There are places where each has the right capabilities—many places where their individual capabilities are essential yet still require special assistance from one or both of the other services to get them there or to make them effective. None can attain its maximum potential without the others' assistance, and its maximum potential alone cannot meet all the requirements of war.

First Poland, then Norway, then Benelux and France were overrun, because the Wehrmacht, except in Norway, did not need to depend upon use of the sea and was not opposed by adequate land or air power. The vastly superior British Navy could not reach the Germans, and its blockade at that time was not sufficiently tight to prevent the German success in Norway. As was to be expected, land power succeeded when not obliged to use the sea, and when not met by adequate land and air power.

"Freedom of action is, to us, the privilege of doing our fighting in some one else's back yard. It is not without reason that after two world wars our United States has had no cities laid in ruins by enemy action. Geography alone is not responsible, for, although the ocean is by nature a pathway for those equipped to use it, wars are not won by lost opportunities.

Loss of the initiative can be disastrous in war. Great cost in time and effort and lives is the usual price we pay to produce the freedom of action of favorable circumstance required to get it back."

But the Wehrmacht was not able to venture the invasion of Britain. British sea power, assisted by the more spectacularly gallant action of the R.A.F., staved off defeat to give a breathing spell. The flexibility was not adequate on either side because the toolbox was not complete. There was no freedom of action to make progress when required.

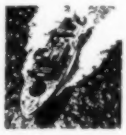
The real political objectives for which the British had risked war had failed. A great hostile power had overrun the continent of Europe and stood poised across the English Channel. Luckily, Hitler did not have the navy that the Kaiser had some twenty-odd years before.

Effect of Sea Power

Freedom of action for both adversaries had to be created anew. It went to those who had sea power. The effect of British sea power played a vastly more evident part in meeting the Axis campaign in Northern Africa, where Axis land and air power were dependent upon use of the sea.

Four long years later, American and British sea power used their amphibious strength to put Allied land and air power into France. It proved adequate under the concurrent circumstances of the Eastern Front, the uncertainty where Allied amphibious power would strike, and other lesser drains on German strength at various other points.

This amphibious power was produced by our Navy and Marines after many prewar years of uninhibited development. It was sharpened by the invention of the Higgins boat, the amtrack, the LST, the combat transport, and other ships and craft of lesser size but not importance. Amphibious power was multiplied, often just in time, by a great industrial effort and a vast training effort as well.



The B-29 was not able to strike Japan with worth-while result until the Navy's amphibious power got them Tinian, Saipan, and, later, Iwo Jima. Flexibility that permits carrying the atom bomb and giving fighter support thereto, together with a wide variety of approach, is not to be discarded lightly. The possibilities of such a combination can serve to tie up (out of all proportion) a vast enemy industrial and military defensive effort.

Unbalance of Power

In 1917 and again in 1941, the United States went to war to redress an unbalance of power and because the wrong side was winning. By winning, our enemies bid fair to acquire military power of unmanageable proportions should they elect to continue their aggressions.

True, other reasons were given at the time, more suitable perhaps to keeping the record straight and conveniently adapted to direct transgressions against us. The freedom of action that goes with public appreciation of the reality of war was missing—this time from the statesman's tool chest.

Now once again our effort is called upon to redress a new unbalance of power caused in major part by unilateral demobilization in 1945-1946. We are once more mobilizing while waging war. The dike of friendly military power, willing to hold for freedom, has been grievously weakened by the ravages of two world wars. It no longer gives freedom of action to postpone our participation at the outset. We are beginning to understand the handicap of empty compartments in our military toolbox. "For whatsoever a man soweth, that shall he also reap" is still sound counsel to be heeded by a nation.

New weapons, like the recently revealed 280-mm. gun capable of firing atomic shells, mean new decisions affecting our economy.

by

W. C. Bober

Economist, Johns-Manville Corporation

rmy photo

Decisions of Destiny

Will Millions for Defense Mean Defense for Millions?

THE defense program is overwhelmingly important economically. But the American people have not yet learned to appraise it realistically. The man in the street still thinks that all that is required is for Congress to vote so many billions of dollars, that the military experts rapidly translate them into an itemized list of goods, and that our wizards of mass production do the rest. Then we all go home and attend to our regular business, secure in the conviction that we are fully armed.

Concept Wrong

This popular concept of defense is totally wrong. It is immeasurably easier for Congress to vote the money than for the military experts to agree what to spend it for. Today, technological progress is so rapid that the tanks and planes and guided missiles of 1952 may be hopelessly obsolete a couple of years hence.

The rate of obsolescence of military goods, in this day and age, is fantastic. That is why it is so dangerous to standardize on military end items and put them into mass production. If we do so we may be caught at the outbreak of war with a tremendous inventory of obsolete equipment.

Many Difficulties

There is a whole set of reasons why it is extremely difficult for the military men to decide what to mass-produce. The difficulties are rooted in the field of international politics, in spheres of strategy, and above all in technological progress.

First of all, we don't know what kind of a war we may have to fight. Our allies of the written treaty may not be allies in fact when the chips are really down. The major basis of our present strategy is retaliatory bombing of Russia's centers of population and industry from bases in allied countries close enough to the Soviet Union to make bombing very deadly and therefore, we hope, to deter her from starting the real thing.

But how do we know how real our allies are? To put it with brutal bluntness—and that is necessary in military matters where the fate of our Nation is at stake—how do we know, for example, that a left-wing government will not succeed Churchill's in England and deny us the use of their bases in the British Isles? The followers of Aneurin Bevan have hinted just that with no excess of delicacy.

How do we know that an independent militarized West Germany will not seek to play East off against West rather than become a new Korea caught in the middle between an invading Russian army and a defending Western force?

Neutralism in Europe

How do we know France will fight any better, or even as well, as in 1940? Neutralism is rampant throughout Europe. We are spending untold millions of dollars on airbases in Morocco and the Near East, but these countries are in the grip of a dawning antiforeign nationalism so that our use of air bases there may be like operating in an enemy-occupied country.

Therefore, if the real thing should come, in say five or ten years, can our military men be sure we will have the air bases abroad from which to carry out our major strategy and hit Russia

at close range? If not, is it better to have huge intercontinental bombers that can take off from the secure bases of our own country or Canada and return home?

With that thought in mind in the first place, we developed the giant B-36 intercontinental bomber. Two years ago it was queen of the air; today it is a prime casualty of technological progress. The development of the jet fighter plane with supersonic speed has made the huge and heavy B-36 a sitting duck with the light fast fighters flying circles around it.

B-36 Lacks Speed

Increase in flying speed has recently been dramatized by the flight of a British Canberra jet bomber across the Atlantic Ocean and back in less than half a day. The B-36's have no such speed. The hundreds of millions of dollars we lavished on them can now probably be charged off to the cost of learning the most fundamental lesson of rearmament. That is, it is exceedingly dangerous and frightfully expensive to standardize too soon on military equipment. You may be mass-producing the wrong thing.

Should the big intercontinental bombers therefore be permanently shelved in favor of smaller faster ones that won't be sitting ducks compared to Russia's MIG's and the much faster jets she is sure to bring out in due time? Assuming our bases abroad will really be there when we want them, that would seem to be a wiser thing.

Or should our bases be mainly giant aircraft carriers—independent of the vagaries of international power politics that could deny us land bases abroad—that can approach within a few hundred miles of an enemy country and hammer her with atomic missiles carried by light, exceedingly fast, bombers?

Production Delayed

All these things have to be thought out and settled before we can mass-produce what it takes to fight or prevent a third world war. A mere congressional appropriation, of even $100 billion for defense, doesn't settle these things. Even the Pentagon cannot rapidly arrive at a correct decision. The international situation is subject to change without notice. And technological progress is a matter of ideas that do not come at even a general's or an admiral's order.

It is like the search for a cure for cancer. No discovery would necessarily

result even if Government appropriated a billion dollars for the search. It is a matter of ideas, and endless, patient research. Likewise with defense: the right sort of bomber, atomic weapon, and guided missile does not follow automatically as a result of the voting of money.

Here, too, it is a matter of ideas and endless research. That process is utterly basic; it is the No. 1 requirement for sound rearmament. Between the appropriation of the money and the mass production of the military end items stands the great broad zone of research, and through that zone we cannot travel at any predetermined speed.

Task Complicated

It is not like just after Pearl Harbor when the task was basically to build more and somewhat better models of the weapons Germany and Japan were known to possess. In this conflict with Russia we barely know what she has at present, and neither we nor she herself knows what she will come up with in the future. We now have to prepare to counter, not existing weapons, but weapons not even yet invented.

The problem is particularly difficult because there is in process of development today a military-technological revolution of the first order. It is not the first time that such a thing has happened in history, but whenever it does happen the fate of the world hangs on it.

"It is not like just after Pearl Harbor when the task was basically to build more and somewhat better models of the weapons Germany and Japan were known to possess. . . We now have to prepare to counter, not existing weapons, but weapons not even yet invented."

When gunpowder was invented and cannon appeared, preponderance passed from the defensive to the offensive. It became easier to hit hard than to block effectively. As a consequence, the stone castles of the feudal system crumbled into rubble, the Middle Ages passed away, and the modern era was born.

Military Revolution

To cite a more recent case of a military revolution, World War I ended with the defensive, based mainly on trenches and machine-gun fire, too powerful for the offensive to crack except at appalling cost in lives and ammunition.

But, in 1940, along came Hitler's generals with a military revolution up their sleeves. They had developed the tank and tactical-airplane combination—the armored panzer teams of World War II—that cracked the defensive wide open.

Defense lines based on the experience of World War I were helpless before it. Preponderance passed from the defensive to the offensive. It was again more effective to hit than to block. Europe collapsed, and the history of the world was changed—as it always is when the full impact of a technological-military revolution reaches the battlefield.

In the air, when World War II ended, the offensive was supreme. The propeller-type bomber escorted by fighter planes of much the same type rained death and destruction on the cities and factories of Germany and Japan. They became punching bags and lost the war. There was no adequate defense.

Quick Decision Dangerous

But we would be foolish, indeed, if we assumed that what happened to the enemy countries of 1945 will necessarily happen to the cities of Russia in, say, 1960 or so. By then they may have developed a powerful defense. So may we, if the enemy tries to bomb our cities. There is now a technological-military revolution under way in the air, the end of which no man can foresee—which is the reason why it is so dangerous to decide too early on what to mass-produce for conflict in the air.

Since the end of World War II, many things have happened that may shift military preponderance in the air from the offensive to the defensive. Radar has been greatly perfected. We are throwing a radar screen clean around the northern limits of America from Alaska across the polar areas and down the Atlantic coast. The radar scope will see the approach of an enemy bomber a great deal farther out than any human eye can see.

The Jet Plane

The jet plane has been invented. Fast defense planes—light jets with supersonic speed that can run circles round heavy enemy bombers—will bring the enemy down before he reaches a target.

The guided missile, invented in the last war, has been immensely developed. When an enemy bomber approaches, these missiles, with deadly warheads, will "home" automatically on the bomber, guided by radar or otherwise.

All this is still very much in the research stage, but it is not impossible that in another five or ten years it will be exceedingly difficult for enemy bombers to reach our cities and factories in the face of radar screens, automatically operated and guided fighter planes, and missiles that home on the bomber unguided by human hands.

But Russia is at work on exactly the same program. She also is throwing a radar screen around her densely populated and industrialized areas. She also is at work, day and night, researching and developing jets, radar, and guided missiles.

Strategy Changed?

If the final outcome is that neither Russia nor the United States can very seriously hurt each other through airpower, then, obviously, the strategic and political picture of the world will have changed fundamentally as a result of one of the greatest military revolutions in all history.

All these possibilities must be taken into account by our military leaders before they can convert congressional appropriations into mass-produced military end items. They cannot, of course, forever consider and weigh and appraise. At some stage or other they must make basic decisions that are in effect gigantic calculated gambles but which must be made nevertheless.

"Patiently we must accept the cold war as a thing that may stretch over generations. Patiently we must research and research with a great many things and ideas until we have the right thing on our drawing boards. Only then can we safely mass produce."

It is these enormously important basic decisions that affect the American economy down to its very roots. We have already had two such decisions, and, of course, more lie ahead.

Decision Made

The first basic decision was made very soon after the outbreak of war in Korea in June 1950. Was it the prelude to World War III or was it a routine aggression in a decade-long cold war? The man in the street guessed the former. He remembered the skyrocketing prices and shortages of the last war. He rushed out and bought everything he could lay his hands on before goods got costlier and scarcer. By that very action he initiated the price inflation he feared. It was not only the average consumer and his wife who lost their heads. We all did, including the Government stock-pilers.

The net result was a rise in prices that might have blown the roof off the national economy together with the greatest accumulation of inventories in our history.

But the Pentagon, by and large, kept its head. It gambled that this was *not* the beginning of World War III. The calculation turned out to be correct.

A basic decision of the first order of importance was made. It was decided to inaugurate a huge defense program, *not* for the immediate production of an immense quantity of military end items for immediate war, as after Pearl Harbor, but of a very different nature. The decision was to do the following:

1. Greatly expand capacity to produce basic materials, such as steel, aluminum, and other nonferrous metals, electric power, oil, chemicals, etc., so that military end items could be produced in vastly greater quantity in case all-out war should actually break out.

2. Build a stand-by plant to make military end items, not in unlimited quantity as in total war but in sufficient volume to equip the new defense forces and to train industry to produce ultramodern equipment when needed.

Guns and Butter

When the implications of this first "basic decision" were fully grasped by business and consumers, the wild economic swell kicked up by the panic fear of immediate total war subsided rapidly. It became plain that, instead of major immediate conversion of civilian plant to armament manufacture, an entirely new defense plant would gradually be built and superimposed on the existing civilian plant. We would have, not guns instead of butter, but guns plus butter.

It became plain that the military was not going to take fifty per cent of the country's national output, but only around twenty per cent, and that only after a considerable period required for research, tooling, and standardizing military equipment.

It became plain that the great majority of industrial plants could continue to produce their regular lines of civilian items. There would be very few shortages of civilian goods, except for those artificially created by hoarding of various items.

Once these thoughts had filtered down into all men's minds there was an abrupt end to panic buying, excessive inventory accumulation, and skyrocketing prices. In short order the business superboom was replaced by a mild recession.

Second Decision

The second basic decision by our military men was made at the very end of 1951 or beginning of 1952. Before that time a tentative defense program had been worked out and widely

publicized which proposed a very rapid rate of defense expenditures reaching a peak of $70 to $75 billions on an annual basis by approximately the end of 1952 and declining very rapidly thereafter until it reached not much over half that level by the middle of 1954 or earlier.

The "Roller Coaster"

This became known as the "roller coaster," and the implications were that 1952 would be a very inflationary year with plant capacity pressed to the utmost, followed by a pronounced and perhaps dangerous economic recession beginning late in 1953. The program's exceedingly rapid rate of arming threatened business stability.

But by end of 1951 it had become plain that we neither should nor could arm that fast. Korea had not developed into World War III. The troubled waters of the world looked less disturbed than right after K-Day. We discovered we had more time for arming than we thought.

But we also discovered many other things with which the first part of this article deals—the long period of research required before one can even design the right military end goods, the time it takes to engineer and tool up, the immensely increased cost of military weapons compared with the last war, the difficulty of deciding what weapons are best and what sort of a war to fight, the technological-military revolution in the air, and, above every thing, the frightful rate of obsolescence of military goods and the danger of being caught with a stock pile of weapons that enemy research and production may render obsolete.

Expenditure "Plateau"

There followed the second basic decision—to "stretch out" the program, to scrap the "roller coaster" and replace it with a "plateau" of annual expenditures of approximately $60 billions for defense for a period of 2 or 3 years. The plateau was to be reached by the end of 1952, and we would slide off it down to a much lower level in, say, 1955 or 1956.

The effect of the decision was to convert an economic climate of extreme urgency and instability into something more serene and stable. Prices, the unfailing gauge of the economic weather, entered a period of relative calm.

But even the two basic military decisions combined have not yet prepared the American public for a fully realistic appraisal of a defense program in a cold war that may at almost any time become a major shooting affair or drag on for a generation or more.

The second decision still implies the fallacy that one can arm up to a high level and then, at one's wish and on the strength of a predetermined schedule, go home and take things much easier. But all that is up to the enemy. Suppose he doesn't do likewise? Suppose he goes on from his own high plateau of arming to a newer high plateau instead of sliding down to a lower level? Suppose he speeds up his research and makes obsolete a lot of the weapons, concepts, and ideas we developed in our plateau period?

Distrust Generated

It is not the history of armament races that nations arm up to a high level and then get tired, slow down, and quit. Too much animosity and distrust are generated during the race to permit so desirable an end.

Tragically, history records that the race accelerates in pace and fury and that nations step up, not down, from one plateau of expenditures to another until there is a showdown. Then there is a general settlement, if diplomacy is sufficiently competent, or, if not, there is a general war.

It is far from impossible that by 1955 or 1956, instead of dropping off from a plateau of $60 billions a year of annual defense expenditures to a lower level of, say, $40 billions, we may be contemplating a new plateau of $100 billions.

I am in no position whatsoever to forecast any such development and I do not forecast it. But I call attention here to the obviously neglected fact that what we will spend in 1955 will not be the result of a predetermined schedule made in the Pentagon in 1951 but of decisions to be made in the Kremlin between now and 1955.

Our Trump Card

Of course, we cannot know what the Kremlin will do, nor can we allow it to keep the perpetual initiative, dictating our rate of defense expenditures. But it is within our power to play a trump card, dictated in any event by the imperatives of the military revolution and the enormously rapid rate of technological progress. And that is *to lay far greater stress on research and much less on early mass production of weapons.*

Lesson from the English

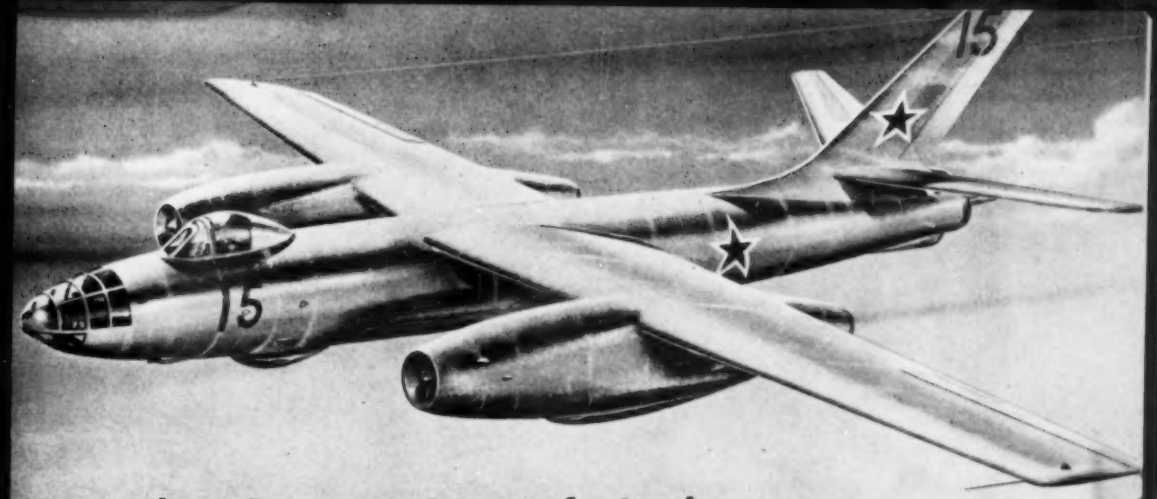
The English are giving us a lesson. They are not mass-producing jet planes of any one kind. They are developing a few of many kinds and each one is the result of intense research to be checked by further research. It isn't we but the English who just flew a jet across the Atlantic and back in half a day. It isn't we but the English who are flying the first passenger jet.

True, it is a gamble to have too small a stock of the right weapons on hand when the chips go down, but it is an even greater gamble to have stored up too many of the wrong and obsolete kind.

To our priceless national talent for mass production we must add the quality of patience, a hard lesson for us to learn. Patiently we must accept the cold war as a thing that may stretch over generations. Patiently we must research and research with a great many things and ideas until we know we have the right thing on our drawing boards. Only then can we safely mass-produce.

Live Serenely

We must learn to live serenely in a dangerous world. We must learn to regard the cold war and defense expenditures, perhaps mounting rather than declining as the years roll on, as constants in the American picture. Defense is a never-ending job. This generation will not finish it and go home. Future "basic decisions" by our military men will make that plain to all our citizens.



The Soviet Aircraft Industry

Could Red Resources Support a Sustained Conflict?

by
William Green

The U.S.S.R. has a high potential for airplane production, but its realization awaits future technical developments

THE world today is becoming increasingly obsessed by the fear of war, and for the past eighteen months the burning topic of discussion in military and naval circles, technical journals, and daily newspapers has been the same—the yawning abyss between the air strengths of the Soviet Union and the West.

Despite the fact that many hundreds of Western aviation experts had an opportunity to make themselves conversant with Soviet military aviation and airplane production during the war years, the difficulties of assessing the present state of the Soviet airplane industry are manifold. It is a serious offense in Russia to publish the most innocent details of military aviation activities or developments or to mention anything of an economic or scientific nature except in the most general terms.

Nevertheless a thin trickle of news continues to percolate through the close security mesh of the iron curtain—items which, in themselves, are unspectacular but, taken collectively, present a picture which, although incomplete, should be taken into our strategic considerations.

Wrong Conceptions

Much has been written by sometimes uninformed, and frequently ill-informed, correspondents who have based their conceptions of Soviet air power purely on the numbers of airplanes that Russia is believed to possess.

Such estimates tend to give a false impression of Russia's ability to fight a sustained air war, for the edifice of Soviet air power has its foundations in an aircraft industry which is beset by numerous difficulties; an industry which would be the object of sustained attack in war and whose size cannot be immediately expanded as can that of the United States.

Depends on Industry

Although numerically, and possibly qualitatively, Soviet air power presents an imposing picture, its true potential can be gaged only from a study of the industry to which it owes its birth.

The Russians possess a natural aptitude for things mechanical and a genius for copying the essential features of a good design and adapting it to suit their own particular requirements. This was proved only too well in recent years by their successful copies of the Boeing B-29 Superfortress and the British Rolls-Royce Nene centrifu-

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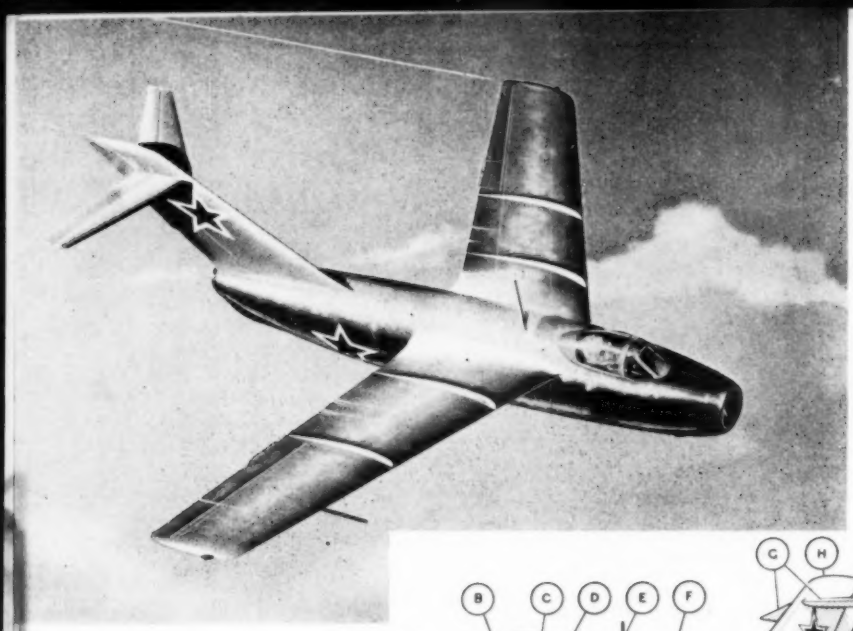
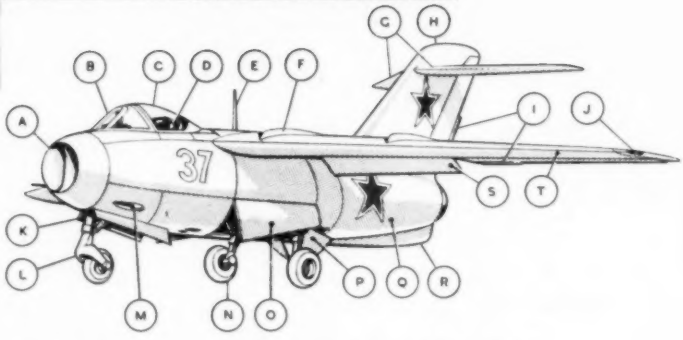
Mr. Green, well-known British aviation authority and aëronautical journalist, is European correspondent for Canadian Aviation.



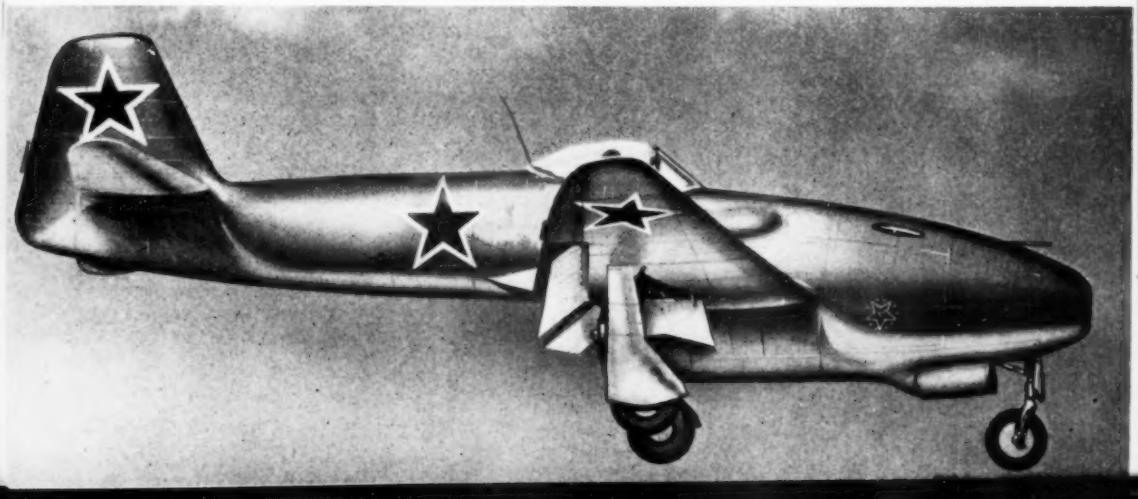
Like the MIG-15, the Lavochkin fighter, above, employs a considerable proportion of aluminum in its construction.



Features of the Lavochkin fighter reportedly designated La-17 include:

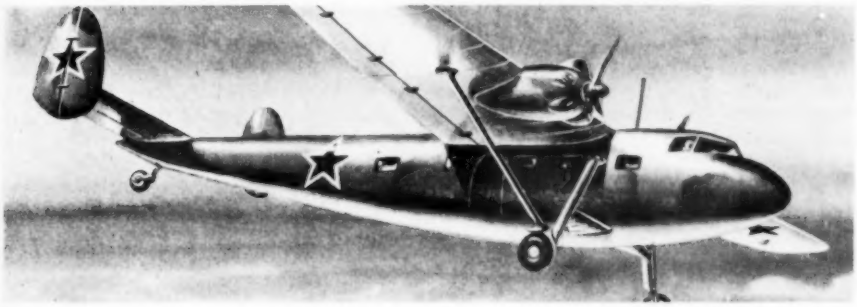
A. Divided air intake to jet engine.
B. Bullet-resisting windscreen panel.
C. Sliding "teardrop" clear-view canopy.
D. Ejection seat for high-speed exit.
E. Obsolete mast signifies T.R. radio.
F. Wing "fences" control spanwise airflow.
G. Tailplane sweepback greater than wing.
H. Large-area sweptback fin.
I. Fixed tabs for ground trimming.
J. Night flying wingtip light.
K. Nosewheel fairing doors.
L. Nosewheel retracts backward.
M. Two heavy-caliber guns.
N. Wheels retract forward into fuselage.
O. Doors enclose main wheels in fuselage.
P. Air brakes slow landing and dive speeds.
Q. Rear fuselage removes for access to jet.
R. Ventral fin area with tail bumper.
S. Landing flaps—used also at take-off.
T. Thirty-degree sweptback wing.

Below, the Yak-15 jet fighter, probably the last Soviet combat plane to make use of both wood and light metal in its construction. This model is now used largely for training and reserves.

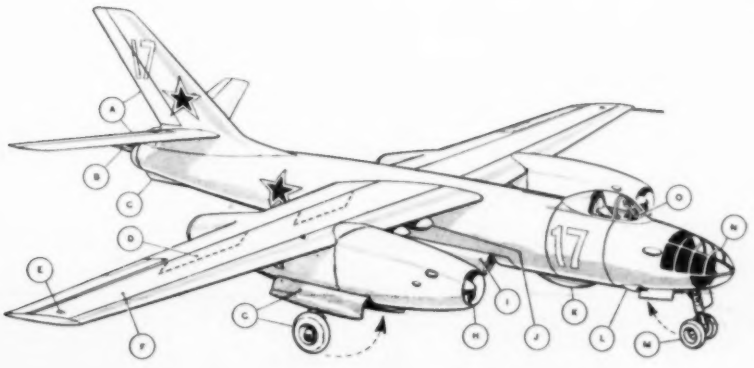


Left, the Ilyushin IL-18, one of the few postwar Russian transports of all-metal construction.

Right, a two-seat operational training version of the Yak-15 single-seat fighter. With an airframe of mixed construction, it has yet to be adapted successfully for the transsonic speeds required in the fighters of today.



Used for liaison duties and training, the Shche-2 twin-motor transport, left, is almost entirely an all-wood-construction machine.



Features of the new Ilyushin all-metal twin-jet bomber include:

A. Sweptback tail surfaces denote high top speed.
B. Twin guns, probably cannon.
C. Tail bumper.
D. Landing flaps and dive brakes.
E. Lights indicate suitability for night flying.
F. Square-cut wing with straight leading edge.
G. Main wheels retract forward, turning 90 degrees to lie flat.
H. Air intake to jet engine, probably axial-flow type.
I. Enclosed internal bomb bay.
J. Extra bombs, rockets, fuel, under inner wing.
K. Perhaps D/F loop or radar.
L. Two fixed guns, firing forward only.
M. Nose wheel retracts aft.
N. Bombardier section.
O. Sliding canopy for cockpit.

gal turbojet engine. Nevertheless, in 1939 the Soviet airplane industry, with an approximate annual production capacity of 10,000 planes of all types, was well below world standards.

The rapidity of the German advance took the Russians completely by surprise. They had made the near-fatal error of deploying too far forward. In addition to losing a large proportion of their front-line airplane strength and a large slice of their reserves, they lost a number of aircraft manufacturing plants, while the bulk of the industry was endangered by the German onslaught.

Decision Made

Thus, the historic decision was made to transfer the majority of the airplane plants west of longitude 45 degrees to the Urals and Siberia, and the successful completion of this stupendous and almost impossible task can be looked upon as one of the greatest industrial achievements of this age. That it was accomplished in so short a space of time and that aircraft design went on smoothly during the move is a mechanical miracle.

Although many of the evacuated plants have since been rebuilt, the wartime move means that European Russia no longer houses the larger part of the airplane industry. The vast majority of the industry's plants are now situated in the Far East, the Urals, and western and eastern Siberia.

The Soviet Air Force overwhelmed the Luftwaffe by weight of numbers rather than by quality, for to our eyes Russian wartime airplanes were crude and strictly functional, accent being on rapid availability rather than fullest fighting efficiency.

20,000 Airplanes

It is reasonable to assess Soviet front-line strength during the closing stages of the war at around 20,000 combat airplanes, of which almost half were fighters. We can usually estimate that first-line strength is about a quarter of the total strength, which includes all immediate and stored reserves, training and other types of noncombat airplanes.

Thus it is reasonable to suppose that fighter production capacity at this time

This unusual sequence of photographs (bottom to top) shows the take-off procedure of the Soviet La-17, a fast jet-powered fighter plane of swept-wing design

was upward of 2,000 units a month, with a monthly production rate of some 500 bombers, 1,000 trainers, and proportionate engine production.

However, it must be remembered that the Russian airplane industry made large-scale use of wood in its airframes, and whether it will prove possible to use partly wooden structures for high-speed jet combat craft is a problem which has yet to be solved in practice.

Manufacturing capacity in the Soviet airplane industry undoubtedly has increased during the past six years. Semiofficial reports put the increase at around twenty per cent. However, the switch from part wood to all metal airframes means that a concomitant increase in the production of light metals would be insufficient to enable the Russians to produce modern jet airplanes in quantities comparable to those of simple, mixed-construction, piston-engined airplanes produced during the late war years.

Four Plants Built

Although at least four large aluminum plants have been built during the past six years, production of raw aluminum as recently as 1948 was only about 165,000 tons as compared with approximately 990,000 tons in the U. S. A. during that year. Recent discoveries of rich bauxite deposits cannot materially affect production for some years owing to shortages of electrical power, water, and transportation with which to exploit the findings.

Only a percentage of Russian aluminum production would be allocated to the airplane industry, and it would be idle to speculate on this percentage. However, if we work on the basis that around sixty-five per cent of the take-off weight of a modern jet fighter is raw aluminum, a machine such as the MIG-15, with a take-off weight of around 6½ tons, would require some 4½ tons of aluminum.

Thus, should 50 per cent of the 1948 over-all aluminum output be allocated to airplane production, approximately 18,300 MIG-15 fighters could be built annually. This is not a very impressive total when one considers that the Soviet Air Force needs, in addition to fighters, tactical and strategic bombers which can only be built at the expense of the former.

Steel Output

But light metals are by no means the only bottleneck in Soviet airplane manufacture, for Russia's 1950 output of steel was only some 26,880,000 tons; less than one quarter of the steel production of the Western powers—even less than the United States produced in 1913.

In 1950, Soviet miners dug some 25,760,000 tons of coal, upon which the production of explosives, synthetic

rubber, and rocket fuels depend. This is less than half American production.

Another critical item in Russia's aviation program is the availability of petroleum products, especially high-octane aviation gasoline. Russia's over-all oil supplies, chiefly obtained from the highly vulnerable wells around the Caspian Sea, total around 41,440,000 tons as compared with United States domestic production of over 296,000,000 tons. This points up the importance to Russia of the 33,600,000 tons which she might obtain from the disputed Persian oil fields.

Power Shortage

The shortage of light metals could be overcome if the most serious of Russia's industrial difficulties could be solved—the shortage of electric power and water upon which her every major armament industry must depend. Some 20,000 kilowatt-hours are required for the production of one ton of aluminum, and Soviet electrical systems generate only about 80 billion kilowatt-hours of usable power at the present time. This is but twenty per cent more than power-starved Britain produces and less than a quarter of U.S. production.

Water at a Premium

Any increase in Soviet power output is dependent on water supplies, and water is at a premium in many of the areas in which the main Soviet armament production centers have been established. Numerous projects exist for improving this situation.

It is upon such schemes as this that the Russians must rely for the attainment of the industrial strength that would be required for a sustained war against the West. But the fruition of the projects is indefinitely delayed by Russia's under-developed system of transportation.

Russia's railways could hardly cope with the requirements of a sustained offensive and cater to strong counter-attacks in both the East and the West, and their inadequacy is partly responsible for the Soviet Union's failure to fully exploit recent mineral discoveries.

The Soviet Union possesses fewer than 65,000 miles of railway (and much of this is single track) compared with the 230,000 miles of track in the U.S.A. Apart from track limitations, shortage of rolling stock is still one of the principal bottlenecks in Soviet economy, necessitating the institution of a plan to build four self-contained "complexes"—Siberia, the Urals, the Moscow area, and the Don. This scheme, however, is far from fruition.

Thus, before Russia can seriously increase combat airplane production she has either substantially to increase electric power and water supplies for industrial purposes or solve the problems of substituting another material for aluminum.

More immediate solutions to difficulties are being found in the manufacture of high-quality aircraft instruments, air-borne radio and radar equipment, and other items. Russia's wartime fighters were equipped with the most elementary instrumentation, consisting of primary instruments only, and fighters as recent as the Yak-15 had radio equipment limited to a simple high-frequency R/T set working on one channel and used primarily for air-to-air communication.

German Assistance

In a recent report, based on information supplied by factory staffs and published in Western Germany, a wealth of detail of the East German contribution to Soviet air power was given. This report shows that East German plants are producing everything from electrical precision instruments, radio and radar valves, optical sights and potentiometers, to airfield equipment and turbojet fuels.

In every branch of the Soviet airplane industry, from initial design to production of turbojets, airframes, instruments, and accessories, the Russians are aided by German technicians. The status of these Germans is not clear. Many are receiving excellent pay and certain privileges to keep them in Russian employ; others less willing to serve the Soviet doubtlessly are forced to do so.

Jet Production

Official sources estimate that the annual Soviet production of airplanes of all types at the present time is between 8,000 and 9,000 machines. Production is heavily concentrated on jet fighters, this type alone accounting for some sixty per cent of the over-all production of military airplanes. The front-line combat strength of the Soviet air forces is somewhere between 20,000 and 25,000 airplanes, but these are by no means all modern machines.

It can be assumed that in a full-scale clash between Russia and the West, the U.S.A.F. would not be deprived overnight of its overseas bases. From such bases in Britain, North Africa, Japan, and other countries, aircraft with the range potentialities of the B-36 could strike any airplane plant in the Soviet Union, either on normal 2-way missions or on shuttle missions employing an alternative base.

Thus, to sum up, it can be seen that from the standpoint of production potential and the ability to wage sustained air warfare, everything but force in being favors the Western allies.

Below is shown the training version of the Ilyushin twin-jet Soviet bomber.

We Can Have Guns and Butter

A Résumé of Two Years of Conservation Progress

George S. Brady

Consultant to the National Association of Purchasing Agents and to the National Production Authority.

AN all-out military effort presupposes in the minds of some that there must be a full allocation of materials and labor to the manufacture of equipment that will be directly useful to the fighting forces with a consequent elimination of production of civilian-type products.

At the high point of World War II, rigid orders were issued stopping completely the production of hundreds of civilian products, and when the new defense effort got under way in November 1950, such was the preponderance of thought in Washington that materials' control orders were prepared and issued to take up where the war orders left off in 1945.

But we have learned much since 1950, and it is safe to say that there are few officials who have gone through the experience of the past two years who have not concluded that a "guns-and-butter" economy is not only possible, but that it is necessary for the United States.

It can be pointed out that in two wars, when Britain had to take the brunt of the attacks, the English people were obliged to accept a strict austerity program with the manufacture of civilian goods cut down to the barest living essentials.

Situations Not Similar

But there is no relation between England's situation in 1939-1945 and that of ours in any foreseeable future. The long range of history shows that great nations are not brought to a siege economy until they are already in a decline.

The position of England as a materials-poor island undergoing a virtual siege on the edge of Europe cannot be taken as a lesson in warfare to America, with industries widely scattered over an immense area, with materials' resources abundant and too diversified to be subject to destruction by any one series of sneak blows, and with far-flung coastlines which in World War II proved capable of importing great tonnages of materials even against the submarines of an enemy more clever than any now in view.

Quality a Factor

Nor does "guns and butter" have the same denotation in the United States as it does in less mechanized countries. There is no possibility that this country, with only 156 million inhabitants, can ever match the number of men that the Communist nations might put in the field. Some quality factor must be overwhelmingly preponderant to determine our success in an all-out struggle—something over and above a superiority of mechanical equipment—and that quality unquestionably lies in the "butter" of our way of life.

Perhaps it would be possible to maintain a crude form of democracy without the material benefits we obtain from our industrial system—the schools, elaborately equipped hospitals, rapid communications, and labor-saving devices for home and farm—but the morale and spirit that have proved the American soldier in Korea to be far superior to the hordes of the Communist dictatorship come not only from the civilizing influences of the little luxuries with which his army is equipped but more directly from the knowledge that his family is well provided for and is maintaining the stability of that civilization for which he is fighting.

What is useful to our military capacity, therefore, goes far beyond the mere term "guns," and embraces much of what other nations would term "butter." It is only necessary that we judge wisely what the "butter" shall be and that we do not waste materials and labor by the incorporation of a "lollipop" economy.

In America, where some 4,400,000 home washers were sold in 1950, the electric washer is one of the products of our civilian manufacturing that has changed the nature of work in the home, freeing women from hard and undesirable labor so that they are able to take an active part in more useful activities.

Worth Fighting For

With such marks of civilization still possible to obtain, the families that maintain the homes of America can feel that home and country are worth striving for, while the families in the wretched homes of the Communist empire, brutalized by arduous labor and food queues, become resentful, despairing of the future, and incapable of concerted effort.

England, even with our great aid, has not been able to recover from the destruction of its civilian industry and trade during the world wars, and it would be taking too great a chance for us to disrupt the industries from whence come the technical genius and the products of our way of life.

The consumer-goods area must not be merely residual; it must be a protected minimum area with sufficient materials supplied to it to keep it functioning healthily.

In the year 1950, which NPA has used as a base period, about 50,000 tons of controlled materials (steel, copper, and aluminum) were used in the production of home washing machines. In relation to the total retail sales value of these machines, more than $800 mil-

lion, and the economic effect on the more than 20,000 factory workers in the industry, this amount of materials is small.

Behind that $800 million in sales is an established manufacturing economy with constantly developing skills and ingenious methods, and it represents a firm foundation from which taxes, both capital and individual, pay for the costs of the direct military effort.

The technical know-how that goes into the superior military weapons produced in our war plants is largely an outcome of the everyday manufacturing of these civilian products. The modern tank is a work of genius, but its electrical equipment, its hydraulic controls, and its communicating devices are products of our civilian production methods.

Take the costume jewelry industry, which in World War II was called nonessential and was completely stopped. In 1950 this industry produced $300 million worth of goods, employed 47,000 workers, and used 18,500 tons of brass, 1,400 tons of nickel silver, and 300 tons of aluminum.

Perhaps we have too much costume jewelry, and the "protected minimum area" for the industry during a major war might be low, but the civilizing influence of jewelry has been recognized from the beginning of time. When the first missionaries went to California to civilize and convert the Indians they brought with them costume jewelry because, as they themselves recounted, the women are the real stabilizers of society, and when the women take interest in making themselves more attractive the home becomes a more secure unit of society.

Toolmakers Trained

But, aside from the value of jewelry itself, the jewelry industry has furnished to American industry ingenious toolmakers and clever mass-production methods. It is a section of our industry that we should maintain at some economic level even when maximum war production brings a shortage of metals.

When it is considered that at the end of World War II we had on hand more than a year's supply of brass, and that there was during the war no time when there was even remote danger of the supply being cut off, we are justified in believing that a little better planning might have avoided some serious economic maladjustments.

During 1951, with only the "residual" allotments of materials, after all military and defense-supporting equipment allotments had been made, the consumer-goods industries, including major consumer appliances and automobiles, were able to maintain production at a little above the 1947-1949 level, besides furnishing the military forces, post exchanges, and foreign-aid agencies with civilian-type goods.

There have been no serious shortages of consumer goods in the past two years, and it was done without diversion of materials from necessary military equipment. By the end of 1951 more than $20 billion worth of military equipment had been delivered, and deliveries were climbing toward $3 billion a month.

Over 800 ships were reconditioned. Electric power facilities were increased 10 per cent in 1951. Machine-tool shipments doubled. About 44,000 new oil wells were drilled and new pipelines built. About 96,000 new freight cars and 2,550 Diesel locomotives were built during the year. Industrial plant expansions in 1951 totaled $11.1 billion. Building of hospital facilities reached a record.

All these "defense-effort" projects took immense quantities of materials, while large amounts of materials were put into the national stock pile and other large amounts of materials went into the manufacture of goods for the foreign aid-programs. Yes, we *can* have guns and butter!

These things were taken into consideration in 1951, and, after a short trial with the restrictive orders of World War II, protected minimum areas were assigned to each industry. With these minimum allotments of scarce metals, the industries were able to keep going on regular production at reduced rates and gradually bring into production new designs with less strategic materials.

By the use of copper-clad steel, silver-clad steel, chromium stainless steel, and more aluminum, the jewelry industry was able to maintain production with less than thirty per cent of the base-period amount of brass. It was found that by design changes it was able to maintain a seventy per cent production of certain items with only twenty-one per cent of the nickel formerly used.

Use of Aluminum

The substitution of steel for brass required changes in production tools, but a change to aluminum could usually be done without serious changes in tools. Where soldering had to be done, copper-clad aluminum was available, but later effective methods of soldering aluminum were developed.

Copper alloys had been standard materials for fifty centuries of jewelry making, but necessity is the mother of invention, and it was now found that for certain items such as earrings and brooches the aluminum had advantages of lighter weight and a wider range of finishes.

As in many other industries faced with the need for substitution during this defense period, precedents were broken and both aluminum and plastics took their rightful place as alternate materials with characteristics better suited to some conditions rather than as substitutes.

Refrigerator and food storage cabinet manufacturers found that for freezing compartments aluminum had advantages over stainless steel in lightness and ease of working. For such parts as housings and trim, electric home appliance manufacturers have been able to use glass-fiber-filled plastics effectively in place of metals.

There are now more than a hundred different plastics on the market, giving a wide range of properties, some of them having a strength-weight factor higher than common metals. While a plastic handle might not be advisable for the rough service of an automobile door, plastic handles and drawer pulls for desks and furniture are fully ade-

quate, and those made to imitate metals by the incorporation of a small amount of the metal powder are superior to the metal in that they never tarnish and are easier to keep bright and clean.

Accent is placed here on aluminum and plastics because it became apparent in 1951 that the aircraft demand for aluminum was not likely to be as severe as it was during World War II and that the production facilities for both aluminum and plastics would increase faster than the military demand.

Polyethylene Plastic

Take the rise in polyethylene plastic which is typical of a number of others and indicates the basic changes that are occurring in materials. Polyethylene is a tough, hard plastic which can be easily injection-molded into all types of mechanical and electrical parts.

Its production began during the war, and the entire output of three million pounds in 1945 was allocated for military products. This year the production is 125 million pounds, and facilities are planned for an annual output of 350 million pounds. It has been replacing metals for many equipment parts, and replacing glass for bottles and vials.

This is also one of the plastics that has been replacing copper and stainless steel for corrosion-resistant tubing and pipes. It is likewise superior to rubber for cable and wire insulation. If only twenty-five per cent of the amount of this plastic is used for injection moldings and piping, this single plastic will replace more than two million tons of metals, saving strategic copper, zinc, chromium, and nickel.

The hundreds of small products that go under the general name of "notions" presented acute problems since these items customarily employ large tonnages of brass and nickel silver in their manufacture.

1,400,000,000 Fasteners

Approximately 1.4 billion slide fasteners were sold in 1950, using 14,500 tons of brass (87.5 per cent copper, 12.5 zinc), 1,200 tons of nickel silver (18 per cent nickel, the balance zinc and copper), and about 2,900 tons of aluminum. The heavy-duty types, used for work clothing and aviation suits, were made of nickel silver, and the general belief was that no other metal could be substituted.

The aluminum used by the industry was employed mostly for pull chains for the lighter-service types, although some fasteners were being made in aluminum by some companies in spite of the prejudices of the clothing manufacturers who were accustomed to brass.

By persistent effort to adjust the alloys to obtain the right balance of wear-resistance and workability, and the fact that the shortage of brass forced the clothing makers to overcome their prejudice, aluminum fasteners were made that were superior to the older brass ones because their color could be adjusted to match the clothing and the anodized metal functioned better than the brass.

Nylon Superior

Heavy-duty fasteners were made of nylon. They not only passed the military tests for strength and functioning but this plastic, which retains its strength at subzero temperatures, was found to eliminate the sticking and breaking that had occurred with metal fasteners on aviation and arctic equipment.

Pins presented a different kind of problem. The common straight pin and the safety pin are almost indispensable items in the American home and the commercial laundry. About 15 million gross of safety pins and 4.1 million pounds of straight pins were produced in 1950. Wherever steel could be used it had been employed because the steel pins are cheaper to make, something over half of the pins being made in steel. But steel corrodes easily and leaves a stain on clothing, so that brass is essential for pins for many uses. The amount of brass used in 1950 was about 2,000 tons.

Here was a case where no satisfactory substitute has ever been found, and it was necessary to allocate brass sufficient to produce an adequate number of pins for the trade.

Snap fasteners were likewise made largely of brass because of their intimate contact with washable clothing. Nearly 14,000 tons of brass were used in 1950 in making snap fasteners, and about 75 tons of nickel had been consumed in plating them. But in this case it was found that aluminum could be substituted for brass for many applications because it is noncorrosive.

Scrap Salvaged

Snap fasteners are used not only for clothing but also for furniture covers, wallets, footwear, surgical belts, camera cases, and numerous other articles. Three billion of them were made in 1950. They are usually made by blanking from strip, and about forty-five per cent of the metal entering the operation is returned to the mills as scrap, so that the actual consumption of metal is not as great as would appear by the allocations.

During the emergency, NPA was accused of favoring aluminum and thus seeking to disrupt some of the old markets which had been virtual monopolies of the brass industry. This is hardly a fair statement of the case. NPA did favor an intensive redesign program to determine if the more plentiful materials could be used instead of copper where the copper is employed in products that never return to the mills as scrap.

Copper a Rare Metal

Such a program is hardly favoritism, since it is in the long-range public interest. Copper is actually a rare metal, the amount occurring in nature being only about one-tenth as much as nickel. It appears to be plentiful only because it is easy to extract from its ores, but about one-third of our supply has to be imported, and nearly forty per cent comes from scrap.

On the other hand, aluminum and magnesium are plentiful metals in nature and require only more production facilities to make them commercially plentiful. When brass is used for such articles as pins, snap fasteners, lead-pencil ferrules, and electric-bulb bases, the copper and zinc in the alloy are never returned to the mills as scrap.

About 11 million gross of lead pencils with metal ferrules are sold an-

nually, and these ferrules take 800 tons of brass. Aluminum ferrules are equal to the brass ones and have the advantage that they can be finished in a variety of colors. Three times as many ferrules can be made from a pound of aluminum as from a pound of brass. But the public had been accustomed to brass, and the retailers would not accept pencils with aluminum tips as long as they could get brass.

Lipsticks and Compacts

Another example of this kind was in lipstick holders and compacts where 18,500 tons of brass were used in 1950. The holders are an assembly of six parts, so that by combinations of aluminum and plastic an almost infinite variety of attractive designs could be made since both aluminum and plastics are capable of many color and finish variations.

But, as with pencil ferrules, it would require a restrictive order to force all manufacturers to make the substitutions and save the copper because of the natural resistance to change.

In the case of electric-bulb bases, where even larger tonnages of brass had been used, no formal order was necessary because it was more economical to make the bases of aluminum, the electrical conductivity of the aluminum alloy was higher than that of brass, and the public readily accepted the white aluminum product.

Venetian Blinds

The Venetian-blind industry consists of about 4,000 companies employing nearly 100,000 persons in making and installing blinds. At the beginning of the Korean war about thirty per cent of all the blinds manufactured were of aluminum. Wood was rapidly going out of use for this purpose since the wooden blinds are heavier and more difficult to keep clean and painted. Steel is more difficult to work and rusts easily. In 1950 the industry used 30,000 tons of aluminum. That would make a worth-while saving of aluminum, and during World War II the aluminum blind industry was put out of business by a restrictive order.

But in 1951 it was almost certain that new production facilities for aluminum would be in operation before the aircraft industry would be consuming large amounts. Under the minimum allotments permitted, the industry was able, by using a thinner gauge of metal, to maintain a satisfactory level of supply without deteriorating the quality of the product.

Some of the most remarkable accomplishments were made in the saving of nickel. It was early shown that this metal would be required by the military in larger amounts than during World War II because of its need in heat-resistant alloys for jet engines and its increasing use for electronic equipment. The largest use of nickel in consumer goods had been in the manufacture of electric ranges, refrigerators, and in a wide variety of home electric appliances where high-nickel alloys were needed for resistance wire.

Government Direction

Because of a possibility of violating the antitrust laws, it was necessary that any setting of standards and limitations to make the conservation industrywise should be done under direction of the Government, and it can be said that the industry advisory committees of the immense and widespread electrical-equipment industries gave an example of coöperation and friendly spirit that was unsurpassed.

Not all companies were able to make the changes in design and methods necessary for the full conservation of metals, as it was realized that the smaller companies were not financially able to retool, but even these manufacturers were subjected to the orders restricting the amount of nickel that could be employed in resistance wire for various heat services.

Although more difficult to work, chromium steels were substituted for nickel-bearing stainless steels, and by using the new types of synthetic enamels that have been developed since the war it was possible to eliminate the ceramic enamels that require both nickel and cobalt in their formulation. As a result of the concerted conservation, it was found that 70 per cent of the base-period number of electric ranges were produced with only 43 per cent of the amount of nickel, and 70 per cent of the number of refrigerators were made with only 35 per cent of the amount of nickel.

Tableware

The second largest use of nickel in consumer goods had been in household silver-plated tableware, where 270,000 pounds of nickel were used monthly in 1950. By using a chromium steel with high silicon and manganese content, knife blades were made that could be highly polished and would keep sharp.

In the base metal for handles and for forks and spoons, the percentage of nickel in the alloy was lowered, and the nickel was entirely eliminated in household hollow ware. With these changes, a seventy per cent rate of production could be maintained with only thirty-six per cent of the former nickel use. In many products where nickel had been ornamental rather than functional, the use of the metal was prohibited, so that the entire production of all consumer goods in 1951 used only twenty per cent of the amount of nickel employed in 1950. About fifteen per cent of all the nickel used in 1950 was consumed as anodes and salts for nickel plating. It was necessary to screen this use carefully to see that none of it was employed merely for decoration.

The examples given are merely typical of thousands of individual cases of substitution and alternation that could be cited. They are sufficient to indicate a trend that would prove that a fairly high production of essential civilian products can be maintained during wartime with relatively low allotments of scarce metals.

Ample Production

By advancing progressively with the type of industry-Government coöperation that was evident during the past two years, it now seems that we will be able to continue an ample production of essential civilian goods, sufficient both for the military forces and the public, without cutting down on any necessary supplies of materials for war equipment.

Chemicals for Defense

Prime Requirement for Military Explosives and Fuels

by
A. M. Ball
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The chemical industry may face plant-capacity and production problems if vital military needs increase

THE external appearance of an item of ammunition, such as a rocket or a round of gun ammunition, shows skilled metalworking, and a layman might well imagine that metalworking comprises most of the production problems of the round. However, on examination of the functioning of the round, one begins to appreciate that chemicals play an important part.

Chemicals Involved

The purpose of most rounds is to place at the target a bursting charge capable of propelling shell fragments for lethal damage, a quantity of incendiary material to burn things, or a charge of smoke-producing composition. These charges are chemicals.

High-explosive charges have to be detonated, and chemical charges have to be opened up so that they can perform their functions. The fuzes that perform these functions involve chemicals.

Gun projectiles, rockets, and guided missiles must be propelled for at least part of the distance from the firing point to the target. The propellants are chemicals.

Finally, or initially, the propellants have to be ignited at the moment of firing. The igniters include chemicals.

Where do all these chemicals come from? In general, they do not occur in nature, nor are they used commercially in any quantity nearly great enough for them to be bought for military purposes. We have, therefore, the problem of producing them. The three most important requirements in the production of a chemical are (1) a process, or know-how, (2) a plant, and (3) a source of raw materials.

High-Explosive Charges

Consider first the high-explosive charges. The most common high-explosive charge is TNT. The most powerful ones, excluding, of course, atomic weapons, contain RDX. In the case of TNT, the process is very well known, as TNT has been used for military purposes for many years.

At the beginning of World War II there was one small TNT plant operating commercially. During the war Army Ordnance built several large TNT plants. Modifications of the process increased the productive capacity to several times the design figure, so that by the end of the war we had a lot more plant capacity than we could use.

It is probable that if the current international situation develops into a "hot" war, we will have most or all of the required TNT plant capacity. It will require only reconditioning.

The raw materials for TNT are toluene, nitric acid, and sulfuric acid. The old chemistry books describe toluene as a coal-tar derivative. There just isn't enough coal-derived toluene to supply our wartime needs for TNT.

Toluene from Petroleum

Fortunately, our petroleum industry had developed processes for making toluene from petroleum, and most of our World War II TNT was made from petroleum toluene. Toluene from this source could probably again be made available, though the hydroforming plants are currently being used to some extent for aviation gasoline and other peacetime products.

Sulfuric acid is an important peacetime product. Existing commercial sulfuric-acid plants, supplemented by reconditioned units in Ordnance plants, would probably carry this load, provided that sulfur does not become scarce. The sulfur picture is not as bright today as it was ten years ago. Present commercial and limited military consumption, plus our export obligations, are using all the sulfur in sight. Programs for conservation of sulfur are receiving considerable attention in industry, and new deposits of native sulfur are being developed.

Uses Curtailed

It is probable, however, that nonmilitary uses of sulfur would have to be curtailed if an extensive war develops. There are, of course, other sources of sulfuric acid than native sulfur. These include pyrites and gypsum. Processes for making sulfuric acid from these are known, but the existing plants are not designed for these processes.

Nitric acid is made by the oxidation of ammonia. Both ammonia and nitric acid are important commercial commodities. Commercial and reconditioned ammonia oxidation Ordnance plants could duplicate World War II production, but military requirements, due to postwar developments, may be considerably greater in a future war. A process for making nitric acid directly from air is under development, and, if successful, it may tend to ease this situation.

Ammonia is made by reacting under pressure (and with a suitable catalyst) nitrogen from flue gas or air and hydrogen from natural gas, coal gas, or water. These raw materials are plentiful. Ammonia capacity in this country

is growing, due largely to increased demand for fertilizer, so there are now very few idle stand-by ammonia plants.

RDX found its first significant military use in World War II. Plants were operated for Ordnance by two processes, each of which had its own particular advantages. The raw materials involved are hexamine and ammonia (nitric acid). Hexamine is the reaction product of ammonia and formaldehyde, and formaldehyde in turn is made from methanol or methane. Important quantities of formaldehyde, and some hexamine, are used commercially, particularly in plastics.

WP is white phosphorus. It is made by reducing phosphate rock with coke in the presence of sand in an electric arc or blast furnace. The production of WP has not slacked off appreciably following the war, as WP is an intermediate in the production of phosphoric acid used in modern fertilizers, and a considerable development of commercial phosphorus-containing chemicals has taken place. Since some of these new phosphorus chemicals may have military uses, it might prove difficult to regain all the wartime WP capacity for shell filling.

FS, used for smoke, is a mixture of SO_3 and chlorsulfonic acid. SO_3 is an intermediate in the manufacture of sulfuric acid, and chlorsulfonic acid is made by reacting HCl and SO_3. FS is produced by the Chemical Corps and its contractors.

Small Peacetime Use

With chemical charges, generally a small high-explosive bursting charge is used to open, but not shatter, the shell. The chemicals used in fuzes for high explosives are lead azide and tetryl. These compounds have a small peacetime use, chiefly in blasting caps. Military requirements were, and will probably continue to be, served by Ordnance plants. Due to their relatively small military volume, raw materials will probably not be a serious problem.

Propellants divide into two classes, liquid and solid, and each class includes groups with different sets of properties and problems. From the chemical standpoint the liquid propellants are simpler, since they are not required to have size and shape. However, the mechanical problems in the use of liquid propellants are more severe, since means must be provided in general to feed them into the combustion chambers during the course of the burning. Storage and handling also are more complicated, since many liquid propellants are volatile, toxic, hygroscopic, and corrosive.

Liquid propellants may be either monofuel or bifuel systems. A monofuel is a chemical individual, having both fuel and oxidizer elements in the same molecule. A typical example is nitromethane, CH_3NO_2. This has been seriously considered by some rocket development agencies, and could conceivably become a requirement.

Nitromethane

Nitromethane appears as a by-product of the nitration of propane, in addition to products used commercially as solvents. It may also be made by the nitration of methane. The raw materials, methane and nitric acid, are available. The process is probably not completely developed, and new plants would be required if a large-volume demand develops.

Bifuel systems are much more common in the liquid-propellant field. A bifuel system consists of a liquid fuel and a liquid oxidant kept in separate compartments in a rocket and fed in separate streams to the mixing device in the burning chamber. A system which ignites spontaneously on mixing is known as hypergolic.

The trend in liquid fuels for aircraft jato and some guided-missile uses is toward the use of gasoline or jet fuel for logistic reasons. Other guided-missile, and some rocket developments, are working with ammonia and hydrazine. The availability of ammonia has been described.

Hydrazine may be made from ammonia by the Raschig process, using hypochlorous acid. The process requires salt and an electrolytic chlorine plant complete with a source of electric power. Studies have been made on alternate methods of preparation, and some experimental work is being done with the long-range objective of producing hydrazine without using the large amount of electric power required by the Raschig process.

Liquid Oxidants

As liquid oxidants, our designers seem to prefer members of the nitric-acid family. WFNA, white fuming nitric acid, is the same concentrated nitric acid as is used in the manufacture of most explosives. RFNA, red fuming nitric acid, is WFNA to which has been added a percentage of N_2O_4. The third member of the family is N_2O_4 itself.

N_2O_4 is an intermediate in the manufacture of nitric acid, and can be isolated in ammonia-oxidation plants by making some minor changes in the plant. Our greatest production capacity is in WFNA, though RFNA and N_2O_4 are more apt to give hypergolic systems and may also have better storage characteristics.

Liquid oxygen, used in the German V-2, is also receiving serious attention. It is made by the liquefaction and fractionation of air, and appears commercially as an intermediate in the manufacture of bottled oxygen used in welding. Process know-how has been extended in recent years so that rather efficient plants could be built for large-volume production. Storage and transportation would, of course, be problems, as liquid oxygen boils at minus 183 degrees Centigrade.

Other Oxidants

Other oxidants under consideration include hydrogen peroxide, now manufactured at above ninety per cent strength, and tetranitromethane. For exceptionally high specific impulses, fluorine, chlorine trifluoride, and nitrogen trifluoride have been suggested. Plant capacity does not exist for these chemicals in adequate volume, and, in some cases, process know-how would also have to be developed.

Solid-propellant grains are required to have size and shape, due to the facts that burning time is fixed by the

web of the powder and that, particularly in the case of charges consisting of one or a few grains, the charge must fit into a prescribed metal part. Solid propellants may be classified into two groups—those depending on nitrocellulose, commonly called smokeless powder, and those using a fuel binder and a crystalline oxidant or composite propellant.

Raw Materials

The raw materials for conventional smokeless powder for guns are nitrocellulose, diphenylamine, DNT, and dibutyl phthalate, and are all chemicals. Nitrocellulose is made from cellulose, which occurs commercially as cotton linters and wood pulp, and nitric and sulfuric acids, already discussed.

Diphenylamine is made from aniline. Adequate diphenylamine plant capacity for gun propellants is installed in one of the Ordnance smokeless-powder plants. DNT is made in an Ordnance TNT plant. Dibutyl phthalate is obtained commercially.

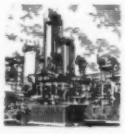
Alcohol and ether are used as solvents and largely recovered. Make-up ether is made from alcohol, and alcohol is available in quantity. The process is well established, and the Government-owned plant is probably adequate for emergencies when reconditioned.

Improved smokeless-powder formulas for gun propellants have been extensively worked on since the war to produce either higher muzzle velocities or reduced flash and erosion. These involve chemicals not previously used in service propellants. Supply problems exist for some of these new ingredients.

Plasticizers

For example, the solventless process necessary for the manufacture of smokeless powder demands formulations containing large amounts of plasticizer. In order to maintain the potential of such powders, a mixture of explosive and deterrent plasticizers must be used. The deterrent plasticizers can be the same ones used in gun propellants; *e.g.*, phthalates. As the explosive plasticizer, nitroglycerin is the usual ingredient in American powders.

The technique of manufacturing nitroglycerin has been well developed by the dynamite industry. Safety considerations have demanded the erection of nitroglycerin units on the rocket-powder plants. Nitration-grade glycerin is available as a by-product of the soap industry and is also made synthetically. The stabilizer used in nitroglycerin-containing powders is Centralite, made from phosgene, aniline, and ethyl chloride, all of which are available commercially. Centralite is made in equipment that also has commercial uses.



The compositions of smokeless powder for rockets have been improved since the war, with the objectives of getting improved performance over a wider temperature range. There are few supply problems in connection with the new ingredients, but there are some mechanical problems, particularly in the application of plastic inhibitors which restrict the burning of the powder to desired locations on the grains.

New Technique

Smokeless powder for jatos and guided missiles comes in grain sizes too large to be extruded even from solventless presses, and a new technique has had to be developed for forming them. This process is now ready for operation on a full plant scale. The raw materials are, in general, the same as are used for rocket powder.

Composite propellants were used for aircraft jatos during the war. They were uniformly smoky, and precautions had to be taken to store them properly and to use them only within a prescribed temperature range. Postwar developments have gone far toward eliminating smoke and improving ballistics, useful temperature range, and general utility. Composite propellants now are also appearing in free-flight rockets.

Raw materials involved in composite propellants are essentially synthetic resins and inorganic perchlorates. The synthetic resins are similar to those used in the plastics, protective-coatings, and adhesives industries and are probably available generally in adequate quantity. The perchlorate requirements may well demand new plant capacity with electric power available.

Black Powder

Igniters or primers to start the burning of propellants contain small amounts of flash or priming composition and larger amounts of black powder. During World War II this country's black-powder capacity was stretched to provide enough black powder for these uses. Since the war, many of the existing black-powder facilities have been dismantled, due to the decrease in commercial black-powder consumption. To some extent other ignition compositions may replace black powder, but black powder could readily become a critical item for us in a big war.

In conclusion, a few generalizations are pointed out:

Nitric acid, sulfuric acid, and phosphorus are chemicals that have important uses both in fertilizers and in ammunition. A country with a well-developed peacetime fertilizer industry is well along the road to ability to produce chemicals for ammunition.

Government-owned Plants

Where commercial production of a chemical is large in comparison with the military requirement, the commercial sources can supply the material. The chemical industry cannot afford to own large plant capacity that has only wartime uses, and, therefore, such plants are Government-owned.

However, the chemical industry has the know-how for the operation of large chemical plants and is better able to hire, train, and supervise the body of employees necessary to operate these plants than a Government organization.

The Government-owned, contractor-operated principle operated well in World War II, most contractors having operated these Government-owned facilities just as efficiently as they operated their privately owned plants.

The chemical industry is proud of its World War II record and stands ready to function again in the same manner should the need arise.

THE THIRTY-FOURTH ANNUAL MEETING

of the

American Ordnance Association

will be held

UNDER THE AUSPICES OF THE NEW YORK POST

at the

Waldorf-Astoria Hotel, New York City

Wednesday, December 3, 1952

The meeting will be a tribute to the United States Navy

Admiral William M. Fechteler, Chief of Naval Operations, will be the honor guest and principal speaker at the dinner meeting in the Grand Ballroom at 7:30 p.m.

In the afternoon, at 3 o'clock in the Sert Room, there will be an Industrial Preparedness Seminar on the present operations and policies of the Munitions Board, John D. Small, Chairman, presiding.

Invitations and reservations have been mailed to all members of the Association. Reservations will close *November 20, 1952*. All excess of receipts over expenditures connected with the meeting will be donated to The Navy Relief Society.

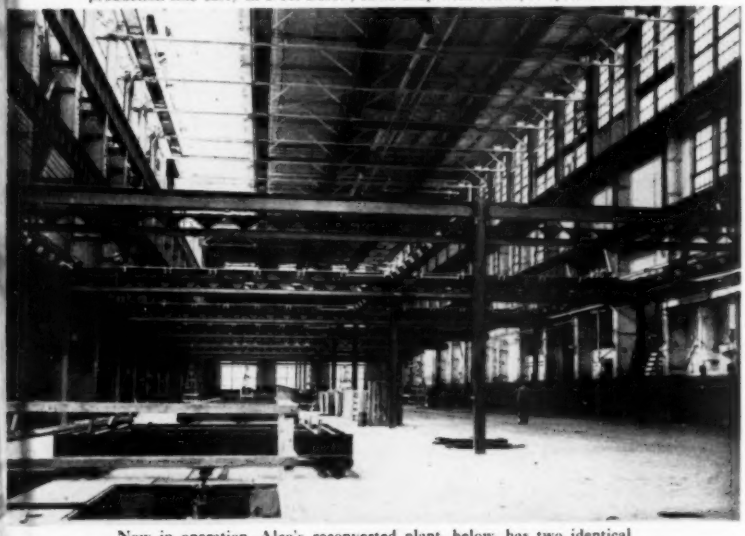
Double Production for Defense

Careful planning produces both defense weapons and industrial products for a sound national economy

A. M. Hamilton

Vice-president, Ordnance Division, American Locomotive Company

Above, Alco workmen start the conversion of a steam locomotive shop to a tank production line early in 1950. Below, same shop with conveyor systems installed.



Now in operation, Alco's reconverted plant, below, has two identical assembly lines feeding into a cross-conveyor where tanks are completed.

HISTORICALLY, the economy of the United States has fallen into the poles-apart categories of peace—or war. Our economy has been based on either all-out production of the weapons of war or on "civilian" production that offered little room for military preparedness.

Cold War

Today, faced by a cold war that may be with us for months or years or decades, we are in the midst of a *semi-military* economy for the first time in our history. In this new economy we must build a huge national arsenal while maintaining regular business at peacetime levels.

There is no immediate need for all-out military production. Yet we must be ready to accelerate to capacity production at a moment's notice. That is the problem facing American industry.

An Example

An example of how industry has responded to these conditions is found at American Locomotive Company's Schenectady, N. Y., plant where many hundreds of the Army's new M47 medium tanks have been produced. Alco's case may be of special interest because it has been able to arrange its

facilities both to turn out tanks and to continue high-level output of Diesel-electric locomotives, essential in meeting growing traffic demands on the Nation's railroads.

This double-barreled production—side by side output of military and industrial essentials—is the result of careful planning. It is based in large part on experience gained in World War II when the company built both steam and Diesel locomotives and tank-type vehicles. Alco was a major tank builder in World War II, turning out more than 7,000 M3's, M4's, M36's, and M7 tank killers, the secret weapon that helped defeat Rommel at El Alamein.

Although World War II production of tanks at Schenectady topped every goal that was set, the terrific pressure of all-out war produced chaotic shop conditions. We were forced to set up tank production in the same shops that turned out locomotives, particularly in the early stages. Improvements in methods were made, with experience, but there never was an opportunity for long-range planning of facilities or production.

When the war ended, Alco turned once again to its primary business of building locomotives. The locomotive business was in a state of change from steam to Diesel, and Alco turned out its last steam locomotive in 1948.

Important Fact

This was important in shaping plans later for the M47 tank program, for space formerly used for building steam engines and since 1948 for storage of Diesel locomotive parts was to become available for tank production.

In 1950, Army Ordnance approached American Locomotive on the possibility of entering defense production at the Schenectady plant. The company quickly surveyed its facilities and indicated an interest in production that would make fullest use, first, of Alco's World War II experience in building tank-type vehicles and, secondly, of basic facilities that were ready-made for production of heavy equipment.

Furthermore, we believed that production of a complete weapon, such as a tank, rather than "bits and pieces," would be in keeping with the Defense Department's long-range mobilization planning. Alco could provide a flexible reserve of plant capacity ready to meet any emergency or a plant which could be "put in moth balls" as a complete manufacturing unit should the international situation be relaxed. The new M47 tank filled the bill from all standpoints, and the company received a letter order to cover building the tanks on November 22, 1950.

The company immediately started preparing its organization and facilities to build the new vehicle. An initial planning staff was recruited from Alco's locomotive division, including a dozen or more men with experience in the company's World War II tank program.

Separation Essential

We knew that to insure utmost economy and efficiency, complete separation of locomotive and ordnance work was essential. An independent organization within the company, known as the Ordnance Division, was created to give its undivided attention to tank production.

With its own administrative staff; engineering, purchasing, and accounting departments; and its own production shop and facilities, it became a going concern on its own but with the strength and resources of American Locomotive Company behind it.

Alco's contract was negotiated at the Detroit Ordnance Tank-Automotive Center and placed through the Rochester Ordnance District. A district Army Ordnance officer for the Rochester District is stationed permanently at the plant.

Design responsibility for the M47 tank has rested with the Ordnance Tank-Automotive Center at Detroit until recently, when Alco was given the authority to take over design work on the tank as a vehicular design agency.

Changes Anticipated

The initial planning staff realized that any tank-building program, as in the last war, would entail a substantial volume of engineering and design changes on a continuing basis. As a matter of fact, even more changes were anticipated under current conditions short of all-out war.

Design Not Finalized

This was particularly true in the case of the M47 which was being released for production by Army Ordnance even before its design was finalized in an effort to cut months from normal design and production periods.

For these reasons, it was decided that separate facilities must be provided within the Ordnance Division itself, apart from the main production line, to modify tanks that had already come off the line. Changes could be introduced on the line as soon as practicable without interrupting the rate of output.

On the basis of these principles, the main tank assembly plant was established in the former steam locomotive shops. In addition, building of a separate modification and testing plant where tanks could be tested, washed, painted, modified, inspected, and shipped was started on an all-out basis. Within five months the main plant and the modification and test center were ready to produce and ship tanks.

To back Alco's own facilities the company set up an organization of subcontractors to give sources of supply for all except those items allocated by the Government. Today, Alco has enlisted some 1,940 subcontractors, of which 375 are prime subcontractors. Second-tier subcontractors number 1,402 and third-tier 163. More than 69 per cent of these subcontractors employ less than 500 workers.

Suppliers are located in twenty-five States. Alco has inspectors and liaison crews working with them to meet the quality-control standards and the production schedules established by Army Ordnance. The company has twenty-five permanently assigned quality-control field inspectors in twenty cities and surrounding areas to help carry out this tremendous program.

The main ordnance plant covers an area of 300,000 square feet and in-

cludes parallel and identical powered assembly lines, each with 14 stations, which feed at right angles into a final assembly line. The conveyor lines are the steel-chain type and can be run at constant speeds.

Built to support the concentrated weights and stresses demanded in steam locomotive production, these shops were ideally suited to the job of assembling heavy ordnance equipment. Even if there were no other advantages to conversion of the area than crane capacities, that factor alone would have made the change-over worth while.

Three Large Cranes

The assembly building was originally equipped with three 150-ton cranes, and six 20-ton cranes operating at a lower level. With no fundamental changes, therefore, the Ordnance Division had at its disposal a building well equipped to handle tank hulls as well as heavy engines and other components.

Fortunately all three 150-ton cranes were not needed in the assembly line area. But the fact that there was an extra one saved at least fourteen months —and more likely eighteen months—in equipping the new tank-modification and testing plant. So important was this consideration that the span for the modification building was purposely designed to accommodate the installation of the third 150-ton crane.

The building in which tank production lines are located, as now modified, has three levels of cranes: the two large ones at the top, the six 20-ton units below, and eighteen small 2-ton cranes. The small cranes are at the disposal of every two assembly stations all along the line. In addition, these stations are equipped with other modern material-handling devices, such as conveyors, fork trucks, and mobile dollies.

Good Layout

Beyond its heavy crane capacity, Alco's Ordnance Division is particularly fortunate in the layout of its production facilities. The main assembly shop is serviced by feeder areas and storerooms on both sides of the line—an arrangement that enables parts to be fed to the two identical and parallel assembly lines without cross-flow of material. Both sides of the building also have their own unloading areas with facilities for receipt of materials by both railroad and truck.

When the finished tank hull is first delivered to Alco's ordnance shops, either by flatcar or by trailer truck, it is unloaded by overhead crane and moved to a storage area—Station 00. As hulls are needed to feed the line, they are moved by crane to Station 0. Here the suspensions, torsion bars, component idlers, road wheels, and drain valves are applied.

From here the hull is again picked up by a 150-ton crane and placed on a dolly at Station 1 at the beginning of the assembly line. The dollies are positioned laterally, so that both sides of the tank are easily accessible to workers operating out of feeder bays along the line. At Station 1, final drives, all universal joints, and personnel heater parts and electrical cables are installed and all suspension assemblies greased.

Lights Applied

The hull on its dolly then moves to Station 2. Here head- and taillights, stowage boxes, mudguards, and radio terminal box are applied. At Station 3, fenders, foot brake and cross shafts, and bilge-pump piping are installed. Moving on through Stations 4 and 5, the hull is equipped with drivers' doors, periscope-housing assemblies, controls, and fuel lines.

Fuel tanks are set in place at Stations 6, 7, and 8, as well as miscellaneous box assemblies and ammunition racks. Equipment installed at Stations 9, 10, and 11 includes air cleaners, seats, crash pads, fire extinguisher and piping. At Station 11 the inside of the hull is cleaned and painted.

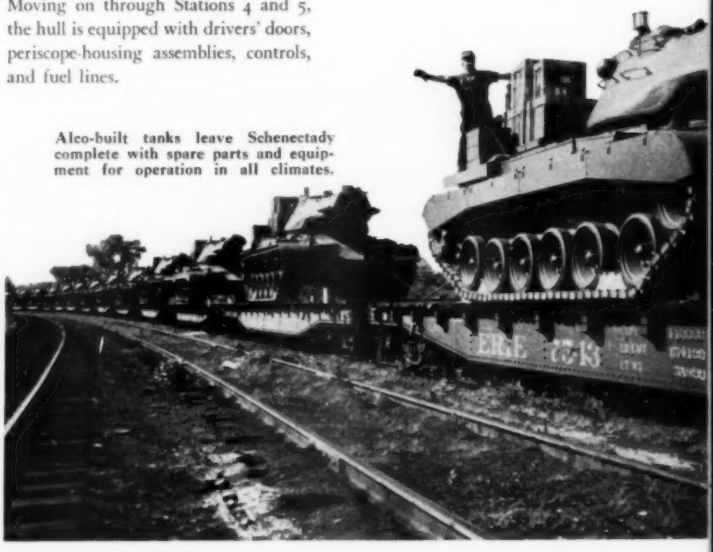
Engine Inserted

The power package, consisting of an 810-horsepower Ordnance-Continental engine with an Allison cross-drive transmission, is lowered into place, and components are connected at Station 12. Exhaust pipes, muffler shields, batteries, speedometers, and top deck grilles are installed at Station 13.

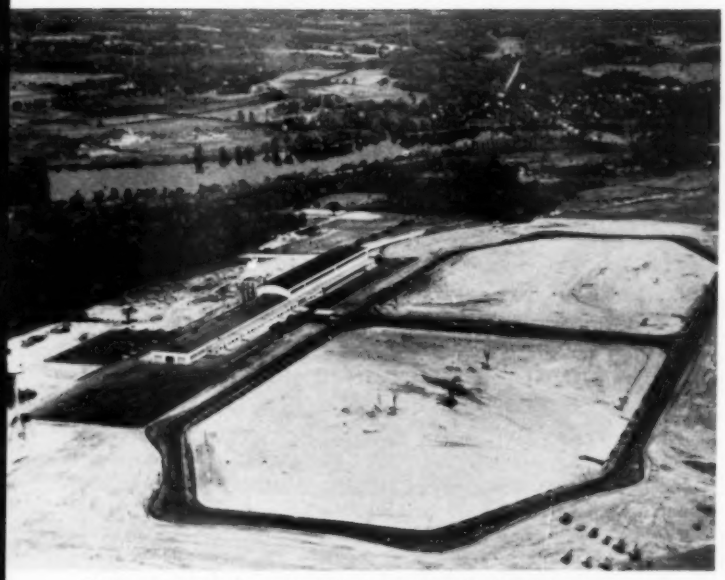
At the last of the 14 stations on the moving lines the hull is inspected, and necessary rework or minor modifications are completed.

Complete tank hulls coming off the double lines are hoisted by crane and placed on the cross conveyor leading into the turret-assembly area. Here for the first time the tank moves along on its own wheels, although its power is supplied by a conveyor chain placed in a metal groove in the shop floor.

The first station on the cross conveyor is 15. Here is an opportunity for further adjustments and minor modifications. The completed hull is towed



Alco-built tanks leave Schenectady complete with spare parts and equipment for operation in all climates.



Tanks are inspected, tested, washed, painted, and shipped from this testing and modification center built on the site of a former golf course.

to Station 16, the paint booth, where the hull is cleaned, masked, and painted. At Stations 17-21, the hull at last becomes recognizable as a fighting tank, for here it receives its turret, which has already been assembled complete with 90-mm. high-velocity gun, fuel-tank covers, gun traveling lock, touring shackles, and seat assemblies. The final assembly station is 22, where the tank receives its tracks, is filled with gas and oil, and finally rolls off the line under its own power.

Taken to Test Center

Following a final production inspection the finished tank is driven aboard a flat-bed trailer and delivered to the company's new testing and modification plant located on the outskirts of Schenectady at the site of an old golf course.

In less than five months from the date ground was broken, December 25, 1950, Alco was able to erect and equip a 1,028- by 78-foot building and erected a 1⅛-mile test or, more accurately, driving track. This track is an oval with a prepared surface eighteen inches thick. It is built to stand the steady pounding of tanks which must grind out fifty miles of road tests before they are ready to be shipped.

For the protection of tanks and personnel, every conceivable safety precaution has been taken. The track is an ample 30 feet wide on the straightaways and a careful 60 feet wide on the turns which, incidentally, are sharply banked at a 15 per cent elevation.

In addition there is an electric traffic system that is carefully supervised at all times. As a final precaution the whole oval is surrounded by a powerful battery of floodlights that make night operations as safe as day.

Although the track is not an obstacle course (the tanks being built to Army Ordnance specifications), it does have a series of 6-inch "washboard" bumps of reënforced concrete to test tank suspension systems. In addition there is a 4-foot-deep "water hole" to test for leaks and the operation of tank floor drains and bilge pumps.

Finishing Touches

After the tanks run 50 miles, they move into the big modification building which is equipped to provide the finishing touches before shipment or to handle extensive modifications if need be. After final inspection and painting, the tank is lifted up by the 150-ton crane and carried to a processing area. Here all moving parts of the engine are coated with a preservative oil which is introduced into the air intake.

Loaded on Flatcars

Once again the big crane moves into action. This time the tank is carried to a flatcar (one of nine which can be accommodated inside the building) which then moves on a specially built railroad spur connecting with the New York Central Railroad. In addition to this railroad siding there are two others—one for receiving the fuel oils that are needed and another to receive "on-vehicle material" such as extra track, pickaxes, etc.

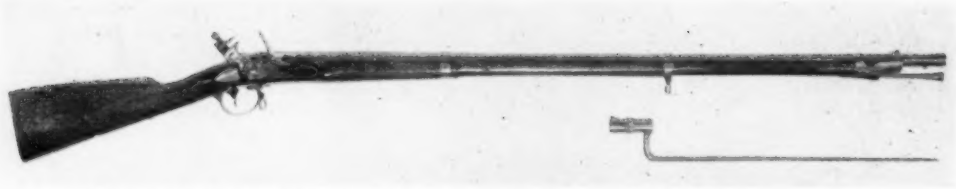
So off the tank goes—the product of the most modern facilities plus old facilities skillfully modified to meet modern needs.

At the main tank plant other special facilities have been installed for processing and shipping spare parts of tanks. The parts section is a completely independent unit including its own receiving and inspection, stores, processing, packaging, and shipping departments. Parts are processed quickly as they pass along overhead and table-level conveyors, through dipping tanks containing protective materials for all climates and into packages and containers.

Facilities Flexible

Alco's Ordnance Division facilities have been designed for flexibility so that they can be tailored to fit a wide range of tank production with no loss of efficiency in case of design changes. This foresight, the result of Ordnance-industry teamwork, will pay its first dividend next year when Alco will switch over to production of the T48 medium tank.

This company, with its double production capacity for both Diesel locomotives and tanks, is typical of many industrial concerns participating in the Nation's program of turning out weapons for defense as well as industrial products for a sound economy.



The muzzle-loading smoothbore caliber .69 Springfield musket, Model 1840, with flintlock firing mechanism.

Flintlock to Percussion Rifle

Fifteen Critical Years in Infantry Weapon Development

by

Jac Weller

Well-known authority on ordnance of the American Civil War

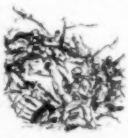
"The infantryman at Sharpsburg had a weapon of power and precision undreamed of fifteen years before"

SHARPSBURG! The bloodiest single day of the bloodiest of our wars! On September 17, 1862, American boys fought among themselves with rifles far more deadly than anything the world had known fifteen years before.

The terrible years of the Civil War saw so many startling changes brought about by the Industrial Revolution of the nineteenth century that the new infantry weapon is often swallowed up as an historical detail. But nothing was so important from a military standpoint—not even the railroad which made possible new strategy nor the explosive shell that doomed wooden ships forever.

First Used in 1346

In Western civilization, firearms were used for perhaps the first time at Crécy in 1346. They scared the horses. No record remains of any one being hurt by them. By a peculiar coincidence the English archer armed with the longbow reached his peak efficiency in this battle. For five hundred years firearms slowly developed. Bows were forgotten. The musket and bayonet became the principal and almost the only arm of the infantry throughout the civilized world.



In our war with Mexico five hundred years later, our infantry was armed with smoothbore muskets, most of them flintlocks. Our Regulars were excellent. Their record in the Vera Cruz-Mexico City campaign is worthy of comparison with anything that soldiers have ever done. They were beautifully trained and disciplined; they were well led and blessed with professional staff work. They overcame impossible handicaps and were victorious.

Longbow More Effective

But the individual United States Regular and his musket was not immeasurably better than the English archer and his longbow of five hundred years before. Logistical and personnel problems, quite as much as battlefield efficiency, had caused the musket to replace the bow. Years of training, individual ambition, and a really first-class physique were required to produce an efficient archer. Supplying arrows and miscellaneous equipment for a bow-armed army of moderate size on a lengthy campaign would be a problem even today. The bow in the hands of a trained archer was faster firing, as accurate and reliable, and longer-ranged than the smoothbore musket.

Recruits Easily Taught

On the other hand, a recruit could learn to handle a musket quite quickly. Firearms were easier to supply with ammunition; they were easier to manufacture, maintain, and store. Neither the flintlock musket nor the bow was much good in a pouring rain, though the bow was less affected by a drizzle. The percussion arms used in the Mexican War would function as long as the paper cartridges were reasonably dry. The caps were waterproof. But the percussion lock was new from a military standpoint. Its use in the Mexican War, according to Col. George Talcott, then Chief of Ordnance, was limited largely to cavalry and riflemen.

You are wondering about the early rifles you have heard about so often—those called Kentucky's and others. For special duty, riflemen have been of importance for auxiliary service since about the middle of the seventeenth century. In the English Civil War, Loyalist gamekeepers sometimes killed Cromwellian gunners at ranges of three hundred yards with breechloading rifles.

No Rifles for Infantry

In our Revolution and in the War of 1812, backwoods riflemen were very

valuable, indeed, when already trained in the use of their weapons and deployed where individual, moderately long range shooting was possible. But infantry of the line were never armed with rifles, save through necessity, in either the United States or any other army prior to the end of the Mexican War, for the simple reason that smoothbore muskets were superior.

The Mississippi Rifle

In our war with Mexico we did use rifles, but not for arming the basic battle-winning infantry. Col. Jefferson Davis commanded a regiment of Mississippi Volunteers armed with perhaps the best rifle in the world at the time. It was officially designated as the U. S. Rifle Model 1841, but came to be popularly known as the Mississippi rifle after this regiment.

It was fine for some forms of duty where only a few slow accurate shots were required. It fired a patched round bullet of almost bore size. Even in skillful hands it wasn't easy to load or reliable for long firing without cleaning.

The vast majority of our infantry, including all the Regulars, were armed with smoothbore muskets. Only a few of these were the new Model 1842 percussion, first produced in 1844. Lieut. Gen. Winfield Scott as well as others in authority didn't want to rely on the new, untried percussion lock.

Old Flintlocks

Our infantry of the line had the older flintlock types which basically were very much like the second-hand British Brown Bess in the hands of the Mexicans. However these smoothbore muskets were effective. Infantry so armed could deliver a tremendous fire in volleys for a long period of time if necessary. The round bullets were so much under bore size that they would load freely even after the barrel was badly fouled.

These muskets were long and sturdy for bayonet combat. Their locks were strong and reliable. They required a minimum of intelligence and of time for mastery by recruits. However, their fire was quite inaccurate. They didn't even have a rear sight. The round balls, after bounding and rolling down the loose bores, were most unpredictable. The power of the powder charge was to some extent lost because of the windage between bullet and barrel.

Short Range

Finally, the round bullets lost velocity rapidly in flight. In very truth their really effective range was limited to the distance one could "see the whites of the enemy's eyes."

Infantry was considered the most important part of any army after the end of armored cavalry. Yet, while the foot soldier was armed with the flintlock smoothbore musket, cavalry and artillery had relative values not greatly inferior, for infantry could be attacked by artillery, cavalry, and even by Indians with bows and arrows.

In the fifteen years before Sharpsburg all this changed—a new weapon appeared in the hands of the infantryman. Because of it, cavalry no longer figured prominently in battles. Artillery could be kept at such long range that its effect was largely psychological. At last the English longbow was completely surpassed in battlefield effectiveness. The new weapon was the percussion Minié-type rifle.

Both the Northern and Southern infantry were armed with this rifle. By September of 1862, even the hard-pressed Confederate Bureau of Ordnance had enough captured Union rifles to complete the efficient arming of all its first-line troops.

The Caliber .58 Rifle

The most common arm on both sides was the caliber .58 U. S. percussion rifle of several closely related models from both Government and private arsenals. The next most numerous weapon was the British Enfield rifle of nominal .577-inch bore. There were also Belgian, German, and Austrian rifles as well as some made in the Confederacy. All took the famous Minié-type bullet; almost all would function with the standard ammunition available on both sides.

These rifles were more effective at a thousand yards than the flintlock muskets had been at two hundred. They could be loaded as easily and quickly as smoothbores and were less likely to foul. They provided in other ways service at least the equal of the older weapons. Their ignition was not dependent upon the weather. Finally, effort spent in target practice was of real value in increased battlefield accuracy.

Three Differences

The new weapon differed basically from the flintlock musket in three fundamentals. First, after two hundred years of supremacy in war, the flintlock was completely discarded and replaced by a percussion lock. In sporting arms the percussion lock was in use to a considerable extent by 1820, yet no army officially adopted it for exclusive use in the field for another twenty-five years.

Though ordnance officers are supposed to be slow to adopt new things, there were good reasons for hesitating to change. General Scott sat on a board of investigation in connection with percussion locks in 1845, yet still

The breechloading caliber .50 Springfield rifle, Model 1866, had the firing pin in the block.

preferred the tried and true flintlock for his troops. We had many thousand new percussion muskets in storage by the end of the Mexican War but used mainly flintlocks in the field, save for riflemen and cavalry.

Secondly, the entire exterior ballistics and trajectory of the infantry arm had been changed. Instead of a round ball revolving by chance from a smoothbore, or even spinning from a pre-Minié rifle, there was a cylindro-conoidal bullet moving gyroscopically.

More Accurate

The new projectile was incomparably more accurate at long ranges than the balls from smoothbores. Spherical bullets from rifles would sometimes give two-hundred-yard accuracy. Beyond that they continued to spin around the axis of the bore rather than their line of trajectory as the Minié projectiles did.

The round balls from the best rifles grouped poorly when this point was passed; the Minié projectiles showed no critical range of this type. Further, the new projectiles, because of their greater cross-sectional density, which allowed them to maintain their velocity better, and their gyroscopic stabilization even at long range, were reasonably accurate for firing at artillery and similar targets up to a thousand yards.

Finally, and most important of all, the Minié bullet could be loaded easily, but it expanded on firing to seal the bore fully and take the rifling. After three hundred years an answer had been found to the problem of accurate fire that also was quick and could be sustained throughout a battle. Let us briefly consider what this meant.

Two Minutes to Load

The seventeenth-century gamekeeper's rifle, already referred to, took at least two minutes to load. It required not only skill but tools. Breechloaders before the advent of metallic cartridges were never satisfactory for line infantry use, though they did have the virtue of firing groove-size projectiles.

Pre-Minié muzzle-loading rifles used the tight-fitting patched-ball similar to our Kentucky rifles and to the British Baker, or even to the more complicated naked-ball system of the German Yaegers. These latter riflemen forced an oversize ball down the bore with a heavy ramrod and perhaps a hammer.

Infantry so armed had little battlefield usefulness.

Even the patched-ball Mississippi rifle already referred to was not really a military success. It could not be relied upon for more than a rather limited number of shots before it became impossible to load with regular ammunition. The narrow rifling necessary to grip the patch covering the round ball was a source of trouble. Fouling quickly accumulated in the grooves of the bore. Discarding the patch meant complete loss of accuracy with only a temporary easing of the loading problem.

The cylindro-conoidal Minié bullet slid easily down the bore and rested upon the charge of powder, where it was held in place by a wad made of the cartridge paper. When the rifle was fired, the powder gases expanded the hollow base of the bullet into the rifling positively and solidly.

Like most mechanical inventions, the Minié rifle was not accomplished in one sudden step, though it did come about quite quickly—all in the second quarter of the nineteenth century. Several answers to the basic problem were proposed and tried. All inventors agreed that the projectile had to pass easily down the rifle bore. Several methods of expanding the bullet once it was in place over the powder, but before discharge, were worked out. These required heavy blows with a formed ramrod, and were never used in this country.

The Minié system of deforming a cylindro-conoidal bullet into the rifling by pressure of the powder gases swept the world. This system was named after Captain Minié of the French Army, though others claim to have invented it prior to him. Actually, his first bullet was to be expanded with a ramrod upon a stem mounted in the breech plug before discharge. That system using a round bullet was then in use in the French Army and named after its inventor, Thourenin.

However, Minié soon dispensed with the stem entirely, since it was unnecessary. He used a hollow-base bullet with an iron cup. The explosion of the charge drove the cup into the cavity, expanding the sides of the lead bullet into the rifling. The cup or plug was usually dispensed with in this country. The powder gases then acted directly upon the slanting sides of the base cavity to accomplish the same purpose.

Positive Expansion

The expansion was so positive and definite that only three wide, shallow grooves were required. These didn't foul nearly so badly as the several narrow deep grooves found in patched-ball rifles. The bullet could be as much as 0.020-inch undersize in diameter. These two conditions made the Minié rifle the equal of the smoothbore in speed of loading since as many rounds could be fired before cleaning was necessary. In fact the bullet tended to clean out the worst of the fouling with each shot, though the rifles were more accurate when they were entirely clean.

The infantryman at Sharpsburg had a weapon of power and precision undreamed of fifteen years before. Further, he hadn't sacrificed any speed of loading or possible number of shots between cleanings to get it. At last he was reasonably independent of weather. This had a tremendous tactical effect on the war.

Napoleon used artillery at close range with telling effect in many of his battles. In fact at Marengo, which he considered to be the crisis of his career, the day was saved by a massed battery under Marmot sending volleys of grape into the Austrians at ranges under three hundred yards.

Jackson at Chapultepec

Stonewall Jackson as a young lieutenant in Mexico commanded a field-artillery section beneath the walls of Chapultepec and won a passage for our infantry across the causeway to the citadel. He stood within point-blank range of the enemy infantry.

These things could not have happened after the advent of the Minié rifle. Artillery had to stay back or seek the protection of earthworks. It could

operate in the open at ranges where it was really effective only by quickly sacrificing itself.

Effect on Cavalry

Cavalry had been of battlefield importance since soldiers first rode horses. Even after the end of armor, horsemen played important parts in large European engagements. Ney tried to break the British squares at Waterloo with tremendous cavalry charges. Murat had more success against the Russians at Borodino. The only cavalry commander of the Civil War to play an important part on a major battlefield proper with his own command was Bedford Forrest whose men fought at Chickamauga, dismounted, with Enfield Minié rifles. Infantry had to be avoided by the opposing cavalry after the new weapons were introduced.

Even more important was the way in which the Minié rifles increased the defensive power of the defeated side in retreat. Victories in a Napoleonic sense were impossible. Once smoothbore-armed infantry lost its organization and was in retreat, its firepower wasn't sufficient to stop pursuit by cavalry, horse artillery, and small bodies of organized infantry. They could be routed by a victorious and determined enemy.

The Minié rifle changed this; even remnants of broken formations so armed were still formidable. Its projectiles would carry reasonably accurately and kill at several hundred yards whether the man firing it was in his usual formation or in any formation at all for that matter. Pursuit turns to rout when panic is created by the actual presence in the retreating column of organized bodies of the enemy. The Minié rifles kept this from happening.

Missionary Ridge

One of the least-praiseworthy battles of the war from the Confederate point of view was Missionary Ridge outside Chattanooga. The entire Southern center broke and fled from an extremely strong position before an attack that wasn't even ordered.

Yet Cleburne's division which had been desperately engaged for hours on the right beating off Sherman's attacks covered the whole retreat. A vastly superior and victorious Union army was not able to interfere greatly with the retreat to Dalton. A single division of less than 4,000 men with fouled rifles was able to hold back Hooker's whole corps of 16,000 fresh men of all arms for hours.

Victory could be obtained by maneuver as at Chancellorsville and Nashville. Frontal attacks were successful only at ghastly price, as in the Seven Days' and at Chickamauga. More often than in any other major war in the past, the defensive side won the battle, as at Fredericksburg, Gettysburg, Franklin, and Atlanta.

Attrition Decided War

The victors in either offensive or defensive battles, however, suffered so heavily at the hands of the Minié-rifle-armed enemy that they could not really press a victory against those same deadly weapons. Attrition played an important part in most battles; it finally decided the war.

In addition to the Minié rifles themselves, there was, of course, the courage, the efficiency, and the skill of the infantry of both North and South. The troops became veterans quickly in the red glare of battles. Their officers were brave; they soon became reasonably efficient. Unlike modern soldiers who must learn a multiplicity of skills, those regiments could concentrate upon a relatively simple task. They worked hard for months and even years with a single weapon. It became part of them; their skill with it was truly superb.

Gordon's Georgia and Alabama infantry on the first day at Gettysburg attacked firing better than four volleys a minute for several minutes. That's fast. They had their percussion caps in their teeth, their ramrods in their left hands, and in many cases their paper cartridges in their trouser pockets.

> **"In the fifteen years before Sharpsburg . . . a new weapon appeared in the hands of the infantryman. Because of it, cavalry no longer figured prominently in battles. Artillery could be kept at such long range that its effect was largely psychological. At last the English longbow was completely surpassed in battlefield effectiveness. The new weapon was the percussion Minié-type rifle."**

Cleburne's Division

From a military sense, Cleburne's division already mentioned was perhaps the best trained in the war. Their fight, both offensive and defensive, against Sherman at Missionary Ridge and against Hooker at Ringgold the next day was essentially a demonstration of peak efficiency in weapon handling. This command made the muzzle-loading Minié rifle more effective than the automatic weapons of World War II divisions, at least in casualty-producing value.

In spite of artists' conceptions, the new rifle put an end to bayonet use save in rare instances.

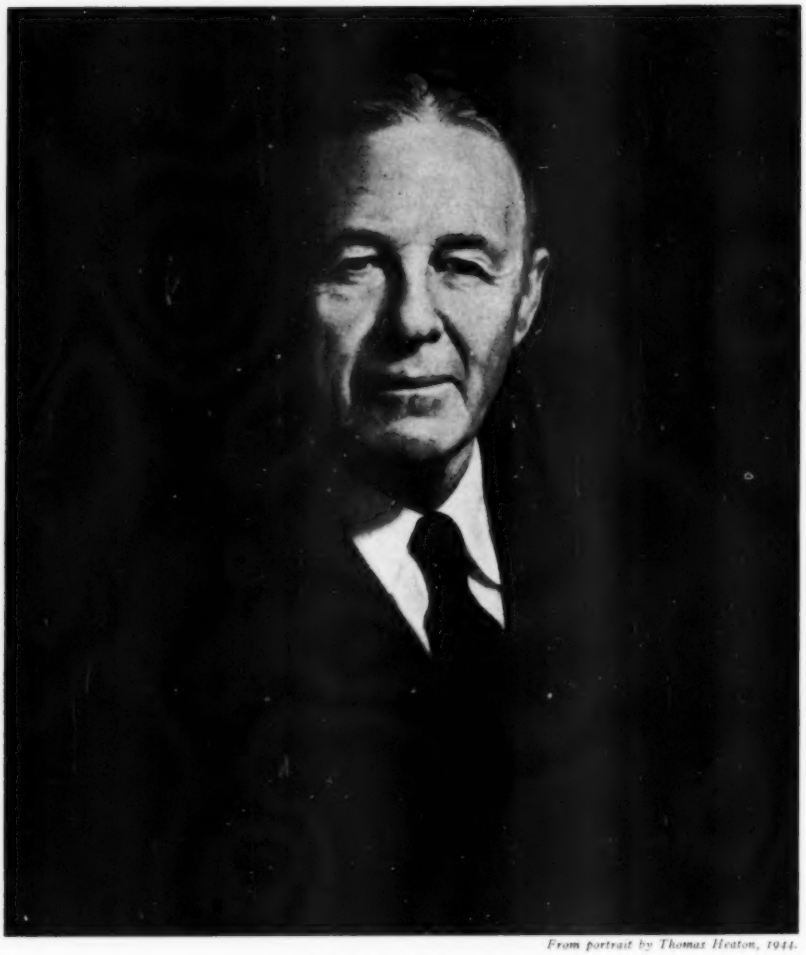
Although sharpshooting in the Civil War was generally confined to actual engagements, the Minié rifles tremendously increased the effective range of this fire. Telescopes were mounted on special rifles using the basic Minié system of expanding bullets.

There are many instances of individuals being fired at and hit by one shot at ranges remarkable even today. Sergeant Grace of Georgia is said to have killed Union General Sedgewick at a range of 800 yards with an English Whitworth rifle.

A Short Career

The Minié rifle had a short career. By the end of the Civil War the Union Army had started to replace it with a variety of breechloading weapons, even for infantry use. The Blue cavalry had few muzzle-loaders after 1863. But never before or since in military history has the potential of the foot soldier so suddenly increased. Today we think of tanks and planes and proximity-fuzed artillery shells. Don't forget that between dawn and midafternoon of September 17, 1862, more American boys were killed and wounded than in the first three weeks of the Normandy invasion!

The fifteen years of ordnance progress from flintlock smoothbore to the percussion Minié rifle may not even be exceeded by the development of tactical atomic weapons.



From portrait by Thomas Heaton, 1944.

BENEDICT CROWELL

Born October 21, 1869 • Died September 7, 1952

GENERAL CROWELL, first president of the American Ordnance Association, was the Assistant Secretary of War and Director of Munitions during the First World War, 1917-1918. He served with distinction as president of the Association from 1919 to 1945.

For a Strong America

THE American Ordnance Association records with deep sorrow the death of Brig. Gen. Benedict Crowell, a member of its Board of Directors and a past president of the Association, who died at Cleveland, Ohio, September 7, 1952. Engineer, student of military affairs, author, financier, and patriot, he served as the Assistant Secretary of War and Director of Munitions in the First World War and as a special adviser to the Secretary of War in the Second World War.

During the intervening two decades as president of the Ordnance Association he led the forces of industrial preparedness in the United States with vigor, prudence, and success. His influence for good in all things connected with the national defense of our country is written large in the annals of our industrial-preparedness progress.

Following the First World War, General Crowell inspired a small group of citizens who were appalled by the lack of preparedness for that conflict, the apathy of our citizens toward armament problems, and the need for keeping alive in time of peace, on the part of American industry, a knowledge of the complete requirements of ordnance design and production in time of emergency.

With the aid of this group—the charter members of the Army Ordnance Association—he turned his efforts toward the importance of the National Defense Act of 1920 which became our national charter of industrial mobilization.

In like degree he gave of his time and effort toward the organization of the Army Ordnance Association, the activities of which he directed as its president for twenty-six years, from 1919 to 1945. In truth he earned the title of Father of Industrial Preparedness in the United States.

In this expression of tribute to a founder and leader during a third of a century, the Association voices its gratitude to a sterling citizen who voluntarily served his country with unwavering fidelity.

During this period, in addition to his official service to the Defense Establishment he served as a member of the Committee on Organization of the Association, as a member of its Board of Directors and its Executive Committee, as chairman of many of its outstanding committees, notably those sponsoring educational orders, the Ordnance district system, and the rearmament program preceding the Second World War.

His kindly, quiet leadership of the forces of industrial preparedness contributed greatly to the attainment of the military and industrial strength existing in our country at the time of his death. To him all our citizens, as well as the members of the American Ordnance Association which he directed so long, owe an abiding gratitude.

—From the minutes of the Executive Committee of the American Ordnance Association at its meeting in Washington, D. C., September 24, 1952.

Month by Month: Highlights of the National Defense

Atomic Artillery

Army Ordnance unveiled an 85-ton, 280-mm. gun firing atomic ammunition at Aberdeen Proving Ground, Md., on October 15, 1952. The new weapon has a range of twenty miles, is completely mobile, and can be made ready for firing within fifteen minutes after arrival at a new position.

It is an all-purpose artillery piece that can fire both atomic and conventional-type shells. The design and development of the weapon date back to 1944, or before an atomic bomb had been perfected.

Army Ordnance made public the following details about the new weapon:

"The gun can give a kind of accurate and devastating close support to ground troops never before available to them in the history of warfare. The gun is the Army's largest-caliber artillery piece having complete mobility.

"It can deliver an atomic shell on target in all kinds of weather, day or night, unlike an air-delivered atomic bomb.

"It can fire with accuracy comparable to conventional artillery in the shorter ranges and is considered to be much more accurate at long ranges—four times more accurate at long ranges than any mobile artillery pieces developed prior to World War II.

"It is carried suspended between two engine cabs, front and rear, which can transport their load on highways at a speed of about 35 miles per hour.

"Although the complete unit ready for traveling weighs about 85 tons, it is not much larger than the heaviest field-artillery piece now in service and can cross bridges capable of carrying any standard piece of equipment in an Army division."

The 40-foot-long gun tube of the new weapon is carried on a flat-bed vehicle drawn and pushed by two tractors. Each tractor cab is powered by 500-horsepower engines. The drivers of the forward and aft cabs communicate with each other by telephone, the forward driver advising the rear operator of changing directions.

The weapon itself is lifted from the traveling carriage by hydraulic jacks. In the 2-gun company formed at Aberdeen, nine trucks accompany the weapon, including two generator vehicles to provide power for the moving gear. (See photos on p. 456.)

Once emplaced, the gun is said to be so perfectly balanced that one man can easily elevate or depress it. Hand-operated emergency gear is built into the jacks for the gun. The weapon represents a highly mobile version of the railway gun of World War I.

Nato Defense

Ambassador William H. Draper, Jr., recently submitted a report to the President on the North Atlantic Treaty Organization. Mr. Draper, United States Special Representative in Europe, arrived in Paris on January 28, 1952. Having served the Army in important assignments, his report covers the first six months of his tenure of office.

With reference to U. S. military aid and offshore procurement, Mr. Draper stated that European defense budgets have more than doubled since the Korean War. These increased resources have been used to build up, train, and equip the armed forces of our NATO partners.

The United States has supplemented the European effort by furnishing heavy armament and other equipment that cannot be produced in Europe in the time and quantities required.

The military assistance from the United States in the form of tanks, planes, artillery, and other weapons is, in Mr. Draper's opinion, indispensable in bringing NATO forces quickly to a status of greater combat readiness. The flow of military weapons and equipment from the United States is increasing but must increase still further in order to provide the European defense forces with the substantial quantities of modern weapons required.

As part of our military assistance, a large-scale program of procurement in Europe was adopted a year ago. The primary objective and the great significance of this step is that it is intended to contribute to the development of a production base which will make it possible for the countries of Western Europe in the future to provide more fully for their own defense requirements.

In addition, these offshore procurement contracts will contribute materially to the effective use of labor and resources in Europe and will help make dollars available for imports needed for defense and civilian production.

Last fall, Army, Navy, and Air Force procurement officers were authorized to begin the placement of offshore procurement contracts in Europe. A multitude of major and minor difficulties and delays was necessarily involved:

Specifications and blueprints had to be translated into many languages; measurements had to be converted from inches and feet into the metric system; contracting procedures normally followed in the United States had to be adapted to conform reasonably with contracting customs and procedures of the NATO countries; special tax agreements had to be negotiated, under which governmental and local taxes were waived on military production financed by the United States.

Time was also necessarily spent in determining appropriate delivery schedules and sources of production and in getting competitive bids from the various plants and countries.

Nevertheless, the three military services carried out the program and actually placed contracts for nearly $700,000,000 of military production in Europe before the fiscal year ended on June 30, 1952. Practically all of this huge total is being produced in nine NATO countries.

Radio Wind System

Wind direction and wind speed are still problems in hitting the target. Greater accuracy can now be obtained, however, as the result of new equipment developed by the Army Signal Corps and described as a "rawin" (radio wind system).

The new system will help gather more accurate facts about wind direction and wind speed. Measurements of this sort are used for forecasting weather conditions, in planning aircraft flights, and in computing ballistic corrections for the trajectory of shells, missiles, and rockets. Such information may also be used to tell in advance which way radioactive materials will scatter.

The "rawin" system consists of a mobile automatic tracking radio direction finder and a new type of radiosonde, or radio set, carried aloft into the atmosphere by weather balloons.

> *The "rawin" set permits, for the first time, continuous automatic tracking of balloon flights and the recording of atmospheric conditions aloft. If necessary, it can be operated remotely.*

The set it replaces had to be manually operated on the spot. The radiosonde transmits weather data back to earth automatically, including information on wind speeds, wind directions, pressure, temperature, and humidity.

Advanced design permits the new set to be used in areas 60 degrees below zero and in steaming tropics and arid deserts.

> *Increased electrical efficiency has been built into the new set. Power used to transmit the signals is less than needed to operate an ordinary 2-battery flashlight.*

The "rawin" set can be carried with troops in the field on a 2-wheel one-ton trailer. It can be broken down and carried by jeeps or manually. The new radiosonde weighs about two pounds and is the size of a telephone.

Gage Savings

The Gage Department of Frankford Arsenal in Philadelphia reports savings of $135,225 in one-half of fiscal year 1952 as a result of modifications of obsolete and unserviceable gages in stock from World War II.

This economy, through modification, has been practiced since V-J Day by the Gage Department and has resulted in savings to date of approximately $750,000.

> *Modification saves the cost of procurement for new gages. It also saves hundreds of pounds of high-grade tool steel which is a critical item at this time.*

One of the purposes of gages is to transfer the skill of measurement from the workmen or inspector to the gage, thus permitting the employment of inspectors of limited skill to perform acceptance inspection of the product.

> *During World War II, the Gage Department of Frankford Arsenal supplied over 800,000 gages for inspection of Ordnance matériel which included intricate gages for inspection of lenses, prisms, fire-control instruments, rockets, jato units, and critical items of ammunition.*

Since World War II gaging techniques have been further developed, particularly the application of electric, electronic, and pneumatic principles in gaging.

An example of the use of gages and the need for accuracy can be shown in the manufacture of an ordinary caliber .30 bullet. The bullet may vary in diameter only one-thousandth of an inch (0.001-inch) which is about one third of the thickness of a human hair. The ring gage that is used to check this dimension may vary in tolerance only one half of one ten-thousandth of an inch which is 0.00005-inch.

The internal measuring machine which is used to check this ring gage (the gage that inspects the bullet) must be accurate to one one hundred-thousandth of an inch (0.00001-inch).

The gage blocks that are used to set the internal measuring machine that checks the gage that inspects the bullet, must be accurate to five millionths of an inch (0.000005-inch). The master block or instrument that measures the setting block, that sets the machine, that checks the gage, that inspects the bullet, must be calibrated to the millionth part of an inch (0.0000010-inch)!

Atomic-Powered Carrier

Secretary of the Navy Dan A. Kimball predicted that the next FORRESTAL-class carrier approved by Congress may be powered by the successful application of atomic energy.

Mr. Kimball said the contract for a large atomic power plant has already been awarded by the Navy, and it is planned to use the engine for "carrier propulsion." He expressed the hope that the third or fourth vessel of the FORRESTAL class will be atomic-powered.

> *Two ships of this class, both of 59,900 tons, have already been approved by Congress. The first of these, the U.S.S.* FORRESTAL, *is now under construction at Newport News, Va.*

Secretary Kimball has previously stated that the Navy will ask Congress for at least one ship of this class every year for the next ten years. He believes that "we need four of these carriers under construction at this very moment." He does not feel that two of these ships are enough. The Navy is therefore going to ask Congress for more of them.

Discussing other developments in the Navy, Mr. Kimball said that "most of the vessels" built during World War II have been modernized and that the program of modernization is continuing along with the Navy's "modest program of new construction."

He also remarked that great advances have been made in the development of guided missiles and in the field of ordnance generally.

> *Sixty per cent of all the ordnance items now being bought are en-*

tirely new developments since the end of World War II.

Secretary Kimball said that in the aviation field "we have several planes now coming into production which can outperform the best planes known to be in the hands of those who oppose our way of life."

Modification of Vehicles

The Army claims that modifications adopted for its tactical vehicles will save an estimated $32,000,000 on equipment to be procured under present contracts.

Such savings are expected to result from more than a year of intensive study in the field conducted by a group of Department of the Army, Army Ordnance, and civilian automotive experts.

The project involved what the Army calls "primary wheeled vehicles"—trucks of ¼- to 5-ton capacity. Specially built models were constructed under relaxed specifications.

One of the primary modifications provides for shallow fording of streams instead of the former deep fording. The trucks now can ford a stream only thirty inches deep. By eliminating certain waterproofing, it has become possible to substitute an open-type generator, which is less costly and more efficient than the closed, waterproofed type.

In addition, it is now possible to use the same generator on all standard Army trucks of from ¼- to 2-ton size. Nine generator assemblies and hundreds of different parts can thus be eliminated.

Other changes include relaxed specifications for radio static suppression. In some cases, less expensive components have been substituted with a resulting increase in the efficiency of the vehicle.

Another feature of the program is the inclusion of "kits" to accomplish certain modifications in the field which will enable vehicles to operate under specific terrain or climatic conditions, such as in the subzero temperatures of an arctic winter.

Aircraft Production

Under Secretary of the Air Force Roswell L. Gilpatric, announced recently that aircraft production in most cases is meeting schedules.

He emphasized the fact that the primary goal is quality, not quantity, and that comparative inventories should take into consideration the great improvements in performance that have been achieved over obsolete and obsolescent planes previously on hand.

Mr. Gilpatric said that the best way to bring out where we stand today in aircraft production, compared with where we were two years ago, was to take as case histories several of our major plane and engine programs. He cited the bomber program as a typical illustration.

"The Air Force at present," he said, "has three types in production and two others in the prototype and preproduction stages, respectively. Of the first three, the B-36 is continuing in production at the Convair-Fort Worth plant where acceptances have been on schedule for over a year—a schedule, I should add, which has not been modified during that time.

"The B-57 light bomber, the U.S.A.F. version of the British Canberra, preparation for the production of which started about a year and a half ago, should begin emerging from the final assembly stage at Glenn Martin early next year.

"Our principal bomber program is, as you all know, the B-47, large numbers of which have been ordered to equip the medium bomber wings of our 143-wing force.

"Two years ago production of the B-47 had barely started; now at Boeing-Wichita, one of the three plants dedicated to this program, B-47's are being turned out at the rate of better than one per day (meaning, of course, working days—most Air Force plants are operating on two shifts, five days a week).

Since Korea, the number of major airframe and engine plants under Air Force cognizance has about doubled. There are now in production for the Air Force over twenty major airframe plants and twenty engine plants, about half of which were not in operation two years ago.

Regarding fighter production, Mr. Gilpatric said that "our two major programs in terms of numbers are the F-84 fighter-bombers manufactured by Republic Aircraft and the F-86 fighter-interceptors produced by North American. Two years ago the entire monthly output of F-84's and F-86's was fifty-five, or less than three of these aircraft a day.

"Now the combined output of Republic and North American is running around 250 a month, or better than 13 a day. It should be added that meanwhile there have been introduced successful improvements into both the Thunderjet and the Sabrejet which, while they have resulted in our having on hand less airplanes of either type, have resulted in superior performance for the airplanes we do have."

Career in Guided Missiles

Secretary of the Army Frank Pace, Jr., recently announced the opening of a new career in guided missiles to enlisted men in the Army. The step was described as a realistic one toward the integration of guided-missile operations into the Army's established weapons system.

Secretary Pace said that qualified enlisted men who desire to volunteer are now authorized to submit applications through normal channels. If selected, the applicants will be transferred, following completion of their normal basic training, to the Antiaircraft and Guided Missile School at Fort Bliss, Tex.

Personnel successfully completing the training at Fort Bliss will become eligible for promotion to the highest warrant-officer grades.

For several years the school has been training relatively small numbers of Army, Navy, and some Air Force officers in guided-missile techniques. The Army pointed out that today, as the development of these weapons nears completion, greater numbers of specialists must be trained.

Save the Stand-by Plants!

An Editorial

SECRETARY of Defense Robert Lovett recently declared that his department did not foresee any departures from present goals and time schedules of the mobilization program. While there may be some "further refinements" in military production, Mr. Lovett indicated that there would be no basic changes in the shape of the defense program.

The armed services expect to realize their major goals by 1955. These are 143 aircraft groups, 16 naval carrier groups, and an Army of 21 divisions.

$129 Billion Voted

Defense Mobilizer Henry H. Fowler reported in October that of $129 billion voted by Congress for military procurement and construction since June 1950, $41 billion have been delivered or used in construction; 58 billions are now in plant or construction pipelines; and contracts covering most of the remaining 30 billions will be let in the next 9 months.

Although pointing to "specific gaps" in the mobilization program, Fowler said "we are, or shortly will be, at the stage where it is feasible to accelerate the scheduled production of many important items of military equipment and to raise our goals—if the national security requires."

Roswell Gilpatric, Under Secretary of the Air Force, announced that the Government has rejected proposals to rejuggle present aircraft and engine production schedules. Last July a report was made to the Aircraft Production Board of the Defense Production Administration recommending Air Force and Navy cancellation of orders for some types of planes and engines, a reduction in orders for other types, and increased production on a few advanced types of planes and engines. These recommendations were formally rejected by the Aircraft Production Board.

The disclosures of Messrs. Lovett, Fowler, and Gilpatric are highly encouraging indications that our gigantic defense program is going forward satisfactorily and that we are daily adding to our military-naval-air strength without serious impairment of our civilian economy. But always there is the problem of adequate storage of our reserve fighting equipment and proper maintenance of our production lines once the present goals are met.

In the first place, it is obvious that the bulk of those costly items which are being produced in such amazing quantities must be stored until such time as needed for combat purposes. Since we never fix our own M-Day we, as a people, can never say just when our defense equipment will be used.

Ordnance organizations of the defense services are making good progress on the storage and battle-ready maintenance of finished armament and parts. But storage problems are certain to multiply now that military production is really rolling. The construction of adequate storage facilities must keep pace with the construction of production facilities.

We know, for example, that the production of tanks and combat vehicles is seven times higher than a year ago. Aircraft delivery in July was well over 800 planes a month. But it would be the utmost folly to build superior tanks and planes and permit them, since they are not immediately needed, to disintegrate in open storage. We just went through that sort of thing a short five years ago, and it is to be hoped that we learned that lesson. We can manufacture the best electronic equipment in the world. But if special care and attention are not devoted to it, such equipment will soon become of no value to any one. There is nothing more useless than a radar system that doesn't work—nor a tank, nor a gun, nor a rocket, nor a pistol!

The storage and maintenance of military equipment are just as important as the production of it—in terms of possible future combat efficiency. To produce vast quantities of military gear and then neglect it is to destroy what we are building and to leave us, in the end, just as unprepared as in the beginning of our defense effort.

The second problem is intimately linked to the first. What will happen to production facilities when defense requirements are either partially or wholly met and such facilities are no longer needed for current production?

Barring an all-out war—which God forbid—in a few years we will be confronted with the problem of the storage and maintenance of machine tools and plant equipment, the problem of stand-by plants, the problem of the second-hand dealers who will want to grab Government production tools out of our hands for a fraction of their value.

Should Solve the Problem Now

The time to deal with this problem realistically is now. Our best brains should be mobilized immediately to work out a national policy that will safeguard our production tools in a state of availability for instant use—in the event that the present "cold war" becomes a global shooting war.

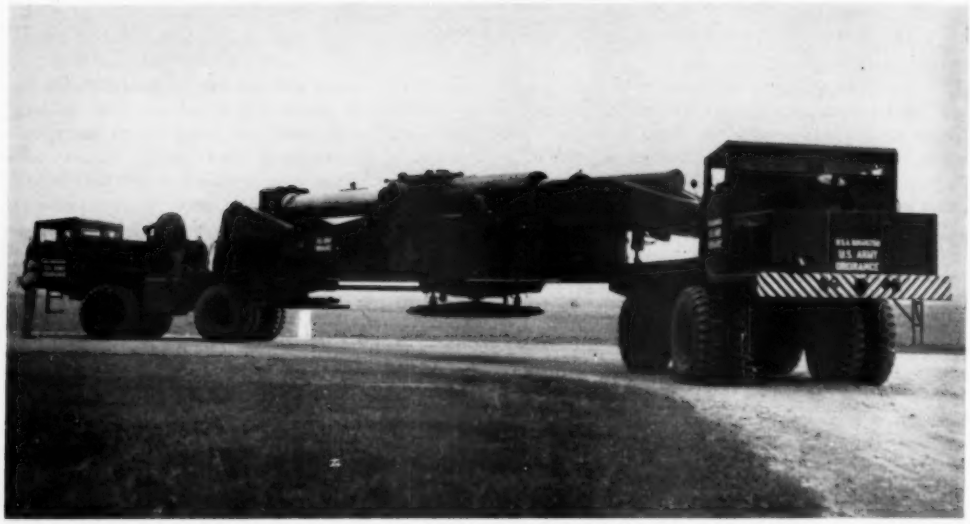
Thus far we know of only two concrete proposals. C. E. Wilson of General Motors has argued eloquently and convincingly in favor of dual-purpose plants, while C. E. Wilson, late of General Electric, has called for the transfer of ownership of military production facilities from government to private hands with an eye to their availability for emergency use.

In either case our Government must keep necessary stand-by plant free of tax burdens and other burdens which would seriously impair our ability to get into all-out production in the shortest possible time in the event of war.

One of the greatest lessons of our short military history is that preparedness is not a matter of months or years. We must be prepared at all times for any war emergency. This means the instant availability for combat use of items already manufactured and adequately stored. It means the ability to go into full wartime production easily, quickly, and efficiently.

Atomic warfare does not tolerate second guesses.

The Army's New Atomic Gun



The Army's newest weapon is the 280-mm. generator-powered gun capable of firing an atomic projectile. Transported by two mammoth prime movers, one at each end, above, it has excellent mobility for an 85-ton weapon and can travel at 35 m.p.h. on the highway. Shown below being set in firing position, the big rifle has a range of 20 miles and unusual accuracy (Army photos).

ASSOCIATION AFFAIRS

• **AT WASHINGTON.**—A day-long meeting of the Executive Committee of the American Ordnance Association, followed by a meeting of the Association's Division and Committee chairmen, was held in Washington, D. C., on September 24, 1952.

By invitation of Hon. Robert A. Lovett, Secretary of Defense, the morning was devoted to an orientation conference in the Secretary's conference room at the Pentagon.

The group was welcomed by the Hon. William C. Foster, Deputy Secretary of Defense, long a member of the American Ordnance Association. Brig. Gen. A. Robert Ginsburgh, U.S.A.F., Office of the Secretary of Defense, then addressed the group, followed by Rear Adm. W. S. Parsons, Deputy and Assistant Chief, Bureau of Ordnance, Department of the Navy. Chairman of the conference was Col. E. C. Moore, Jr.

Later in the morning the group was addressed by Brig. Gen. Leighton I. Davis, U.S.A.F., Director of Armament, Air Research and Development Command; by Maj. Gen. Leslie E. Simon, Chief of the Ordnance Research and Development Division, Office of the Chief of Ordnance; and by Col. John A. White, on behalf of the Chief of Research and Development, Office of the Chief of Staff, U. S. Army.

Following the Pentagon session, the group had luncheon at the Carlton Hotel in Washington. Herbert A. Gidney, senior vice-president of the Association, presided. Informal remarks were made by Maj. Gen. E. L. Ford, Chief of Ordnance, U. S. Army; Rear Adm. M. F. Schoeffel, Chief of the Bureau of Ordnance, U. S. Navy; and Lieut. Gen. Orval R. Cook, Deputy Chief of Staff, Matériel, U.S.A.F.

At 2:30 p. m. the members of the Executive Committee convened. Those present included Colonel Gidney, Harvey C. Knowles, Louis Polk, Robert L. Biggers, C. Jared Ingersoll, R. E. Gillmor, Henry P. Erwin, John Ross Delafield, Leo A. Codd, and Florence G. Ferriter.

Also present were E. R. Godfrey and C. Stewart Comeaux, directors of the A.O.A., and John Pfeil, a vice-president.

At four o'clock a meeting of Technical Division and Committee chairmen was held. Mr. Polk, a vice-president of the Association, presided.

A buffet supper was served at six o'clock. There were no speeches and adjournment was at the individual pleasure of the guests.

Participants in the day's program, including those mentioned above, were the following, representing the armed forces:

Maj. Gen. J. K. Christmas, Chief, Procurement Division, Office, Chief of Staff, U. S. Army; General Cook; Dr. S. D. Cornell, Director, planning division, Research and Development Board; Maj. Gen. E. L. Cummings, Chief, Industrial Division, Office, Chief of Ordnance, U. S. Army; Brig. Gen. Leighton I. Davis;

Brig. Gen. Merle H. Davis, Chief, Ammunition Division, Industrial Service, Office, Chief of Ordnance, U. S. Army; Maj. Gen. Fred. R. Dent, U.S.A.F., military director for production and requirements, the Munitions Board; Adm. William M. Fechteler, Chief of Naval Operations; Hon. John F. Floberg, Assistant Secretary of the Navy for Air and Comptroller of the Navy; Maj. Gen. E. L. Ford, Chief of Ordnance, U. S. Army; Hon. William C. Foster, Deputy Secretary of Defense; Vice Adm. C. W. Fox, Director of Matériel, Navy Department; General Ginsburgh; Nathaniel Knowles, Jr., Vice Chairman for Materials, the Munitions Board; Lieut. Gen. T. B. Larkin, Assistant Chief of Staff, G-4, U. S. Army;

Hon. W. J. McNeil, Assistant Secretary of Defense; Col. E. C. Moore, Jr., Chief, National Organizations Branch, Office of the Secretary of Defense; Maj. Gen. George H. Olmsted, Director, Office of Military Assistance; Rear Adm. W. S. Parsons, Deputy Chief, Bureau of Ordnance, Department of the Navy; Admiral Schoeffel; General Simon;

A. E. Van Cleve, director, New York Post, American Ordnance Association, Assistant to the Secretary of the Army; Walter Whitman, Chairman, Research and Development Board; Capt. Edward L. Woodyard, commanding officer, Naval Ordnance Laboratory, White Oak, Md.

Representing the American Ordnance Association were:

Joseph L. Auer, chairman, Recuperator and Equilibrator Committee, and vice-president, New York Post, American Ordnance Association; president, R. Hoe & Company, New York, N. Y.

G. F. Ball, deputy chairman, 20-mm. Brass Cartridge Case Committee, American Ordnance Association; Nesco, Inc., Milwaukee, Wis.

Robert L. Biggers, vice-president, American Ordnance Association and president of its Michigan Post; president, Fargo Division, Chrysler Corporation, Detroit, Mich.

Chester W. Bissell, Small Arms and Small Arms Ammunition Division, American Ordnance Association; Savage Arms Corporation, Utica, N. Y.

W. M. Brandes, Fire Control Instrument Division, Jewel Bearing Committee, American Ordnance Association; vice-president, Elgin National Watch Company, Elgin, Ill.

H. A. Brown, chairman, Rifles and Carbines Committee, American Ordnance Association; Remington Arms Company, Bridgeport, Conn.

James E. Burke, chairman, Fuze Committee, American Ordnance Association; Stewart-Warner Corporation, Chicago, Ill.

Charles H. Carter, Jr., cochairman, Powder and Explosives Committee, American Ordnance Association; Atlas Powder Company, Wilmington, Del.

Wallace L. Clay, secretary, Small Arms and Small Arms Ammunition Division, American Ordnance Association; Remington Arms Company, Bridgeport, Conn.

Leo A. Codd, executive vice-president, American Ordnance Association, Washington, D. C.

C. Stewart Comeaux, director, American Ordnance Association; Sporting Arms and Ammunition Manufacturers' Institute, Oklawaha, Fla.

John Ross Delafield, counsel, American Ordnance Association; Delafield, Marsh & Hope, New York, N. Y.

Weber deVore, secretary, Rocket Committee, American Ordnance Association; Heintz Manufacturing Company, Philadelphia, Pa.

F. J. DeWitt, chairman, Surface Preservation Committee, American Ordnance Association; vice-president, Parker Rust Proof Company, Detroit, Mich.

C. L. Eksergian, chairman, Rocket Committee, American Ordnance Association; Budd Company, Philadelphia, Pa.

Harry Erlicher, member of Council and past president, Capital Cities Post, American Ordnance Association; Assistant to

the Under Secretary of War, Washington, D. C.

Henry P. Erwin, treasurer, American Ordnance Association; director, Riggs National Bank, Washington, D. C.

Walter E. Faithorn, assistant secretary, Fuze Committee, American Ordnance Association; Stewart-Warner Corporation, Washington, D. C.

Herbert A. Gidney, vice-president, American Ordnance Association; Gulf Oil Corporation, Hyannis Port, Mass.

J. S. Gillespie, chairman, Carbide Cutting Tool Committee, American Ordnance Association; General Electric Company, Detroit, Mich.

E. R. Godfrey, director, American Ordnance Association; vice-president, General Motors Corporation, Detroit, Mich.

Ralph L. Goetzenberger, deputy chairman, Fire Control Instrument Division, American Ordnance Association; vice-president, Minneapolis-Honeywell Regulator Company, Washington, D. C.

Britton L. Gordon, member of Council and director, Western Michigan Chapter, American Ordnance Association; president, Blackmer Pump Company, Grand Rapids, Mich.

F. M. Hakenjos, cochairman, Powder and Explosives Committee, American Ordnance Association; Hercules Powder Company, Wilmington, Del.

C. R. Hellstrom, chairman, Pistols and Revolvers Committee, and director, Hartford-Springfield Post, American Ordnance Association; president, Smith & Wesson, Inc., Springfield, Mass.

A. W. Herrington, member, Advisory Board, American Ordnance Association; chairman of the board, Marmon-Herrington Company, Indianapolis, Ind.

H. M. Heyn, chairman, Heating and Heat Treating Furnace Committee, American Ordnance Association; Surface Combustion Corporation, Toledo, Ohio.

Stanley C. Hope, member of Council and president, Hartford-Springfield Post, American Ordnance Association; chairman, Fire Control Instrument Division, American Ordnance Association; president, Esso Standard Oil Company, New York, N. Y.

Rex Howard, Renegotiation, Contract Cost Principles and Current Pricing Practices Committee, American Ordnance Association; Olin Industries, Inc., Washington, D. C.

Walter N. Howley, member of Council; deputy chairman, Rocket, Bomb and Artillery Ammunition Division; and chairman, Shell Committee, American Ordnance Association; president, Lansdowne Steel & Iron Company, Morton, Pa.

George F. Hussey, Jr., member of Council and president, New York Post, American Ordnance Association; managing director, American Standards Association, New York, N. Y.

C. Jared Ingersoll, national director and director of the Philadelphia Post, American Ordnance Association; Kansas, Oklahoma & Gulf Railroad Company, Philadelphia, Pa.

Dudley S. Ingraham, chairman, Watch and Clock Committee, American Ordnance Association; Ingraham Company, Bristol, Conn.

J. L. R. Johnson, Jr., chairman, Procurement Regulations and Contract Terminations Committee, American Ordnance Association; general counsel, Hercules Powder Company, Wilmington, Del.

M. H. Johnson, member of Council and president, Mid-Continent Post, American Ordnance Association; Independent Plow, Inc., Neodesha, Kans.

C. L. Kent, chairman, Cold Finish Bar (Shell) Committee, American Ordnance Association; Jones & Laughlin Steel Corporation, Pittsburgh, Pa.

Ludlow King, president, Washington Post, American Ordnance Association; Fiberglas Corporation, Washington, D. C.

Harvey C. Knowles, vice-president, American Ordnance Association, and director of its Cincinnati Post; vice-president, Procter & Gamble Company, Cincinnati, Ohio.

John W. Kraus, chairman, Preservation Committee, American Ordnance Association; Thompson Products, Inc., Cleveland, Ohio.

A. J. Langhammer, chairman, Powder Metallurgy Committee, American Ordnance Association; president, Amplex Division, Chrysler Corporation, Detroit, Mich.

E. J. Lauenstein, deputy chairman, 20-mm. Projectile Committee, American Ordnance Association; American Safety Razor Company, Brooklyn, N. Y.

Burton O. Lewis, staff consultant for Technical Divisions and Committees, American Ordnance Association, Washington, D. C.

J. A. MacDonnell, secretary, Fire Control Instrument Division, and secretary-treasurer, Hartford-Springfield Post, American Ordnance Association; Gilbert & Barker Manufacturing Company, West Springfield, Mass.

James D. Maitland, member of Council and president, Rocky Mountain Post, American Ordnance Association; president, Cobusco Steel Products, Denver, Colo.

A. Muller, chairman, Welding (Shell) Committee, American Ordnance Association; Air Reduction Corporation, Murray Hill, N. J.

Howard F. Neilson, secretary, Surface Preservation Committee, American Ordnance Association; Neilson Chemical Company, Detroit, Mich.

E. F. Norelius, member of Council and director, Central-Illinois Post, American Ordnance Association; Allis-Chalmers Manufacturing Company, Springfield, Ill.

Terrence C. O'Donnell, chairman, Mechanical Fire Control Committee, American Ordnance Association; executive vice-president, Gilbert & Barker Manufacturing Company, West Springfield, Mass.

A. D. Peister, chairman, Heavy Wooden Crates and Cases Committee, American Ordnance Association; General Motors Overseas Operations, New York, N. Y.

Walter C. Pew, member of Council, American Ordnance Association; Sun Oil Company, Philadelphia, Pa.

John S. Pfeil, vice-president, American Ordnance Association; chief, Boston Ordnance District, United States Army; vice-president, Stone and Webster, Inc., Boston, Mass.

C. F. Pickett, member of Council and director, Aberdeen Proving Ground Post, American Ordnance Association, Aberdeen Proving Ground, Md.

Louis Polk, national vice-president; chairman, executive board, Gage Industry Division; and director, Cincinnati Post, American Ordnance Association; president, the Sheffield Corporation, Dayton, Ohio.

S. E. Reimel, member of advisory board, American Ordnance Association; Ten Eyck-Wade-Butler Associates, Washington, D. C.

W. J. Reitze, chairman, Metal Lubricants Committee, American Ordnance Association; Esso Standard Oil Company, New York, N. Y.

W. T. Roach, chairman, Optical Committee, American Ordnance Association; Eastman Kodak Company, Rochester, N. Y.

William J. Rushton, member of Council, American Ordnance Association; chief, Birmingham Ordnance District, United States Army; president, Protective Life Insurance Company, Birmingham, Ala.

Frank E. Shumann, chairman, Casting Committee, American Ordnance Association; Lehigh Foundries, Inc., Easton, Pa.

S. E. Skinner, member of Council and member, executive board, Artillery Division, American Ordnance Association; vice-president, General Motors Corporation, Lansing, Mich.

Thomas C. Smith, deputy chairman, Fuze Committee, American Ordnance Association; Daystrom Electric Corporation, Poughkeepsie, N. Y.

R. F. V. Stanton, chairman, Gun Carriage and Mount Committee, American Ordnance Association; vice-president, American Machine & Foundry Company, New York, N. Y.

H. B. Stoner, chairman, 20-mm. Brass Cartridge Case Committee, American Ordnance Association; Stoner Manufacturing Corporation, Aurora, Ill.

R. L. Telford, member of Council; chairman, Rocket, Bomb and Artillery Ammunition Division; and vice-president,

Louisiana Post, American Ordnance Association; first vice-president, Silas Mason Company, Shreveport, La.

J. E. Trainer, national director; chairman, Artillery Division; and director, Cleveland Post, American Ordnance Association; vice-president, Firestone Tire & Rubber Company, Akron, Ohio.

Paul O. Vogt, member of Council and chairman, Packing and Packaging Division, American Ordnance Association; General Electric Company, Schenectady, N. Y.

J. Carlton Ward, Jr., member of Council, American Ordnance Association; adviser, Industrial College of the Armed Forces, Farmington, Conn.

Thomas P. Wharton, member, Corrugated and Waterproof Paper Containers Committee, American Ordnance Association; Container Laboratories, Inc., Washington, D. C.

M. P. Woodward, chairman, Loading Committee, Rocket, Bomb and Artillery Ammunition Division, American Ordnance Association; Procter & Gamble Company, Cincinnati, Ohio.

R. C. Zeller, chairman, 20-mm. Projectile Committee, American Ordnance Association; Defiance Automatic Screw Company, Defiance, Ohio.

• **AT NEWARK.**—A regional meeting of the American Ordnance Association was held under the auspices of the Philadelphia and Aberdeen Proving Ground Posts at the Chrysler Delaware Tank Plant, Newark, Del., on October 9th.

The meeting was arranged, with the approval of Maj. Gen. E. L. Ford, Chief of Ordnance, U. S. Army, and L. L. Colbert, president of the Chrysler Corporation, for members of the following Posts of the Association: Yankee (Boston); Hartford-Springfield; Capital Cities (Schenectady); New York; Pittsburgh; Washington, D. C.; Aberdeen Proving Ground; and Philadelphia.

The purpose of the meeting was to acquaint Association members with the latest production techniques affecting the design and manufacture of modern tanks for the armed forces of the United States. Nearly 2,000 members of the Association attended the meeting.

In the afternoon following luncheon there was a field demonstration of maneuverability and operation of the famed Patton 48 medium tank now in quantity production at the Chrysler Delaware Tank Plant.

The following distinguished military and industrial leaders addressed the meeting: Lieut. Gen. E. Brooks, commanding general, Second Army, Fort Meade, Md.; Maj. Gen. J. K. Christmas, chief, Procurement Division, Office, Chief of Staff, U. S. Army; Brig. Gen. J. L. Holman, commanding general, Aberdeen Proving Ground, Md.; Mr. Colbert; and R. T. Keller, general manager, Chrysler Delaware Tank Plant. Albert W. Gilmer, president of the Philadelphia Post, was toastmaster at the luncheon and introduced the speakers.

The meeting began at ten o'clock in the morning and concluded at four o'clock in the afternoon. A special train brought the Philadelphia Post contingent of nearly 500 members. Other Posts were represented by large groups of members including the Aberdeen Proving Ground Post under its newly elected president, B. S. Goodwin, and its vice-president, Thomas F. Colleran. Other personnel of the proving ground contributed to the success of the demonstrations.

The Chrysler Delaware Tank plant is one of several industry-operated plants producing the new Patton 48—the first wholly postwar medium tank—"a unit of great striking power, mobility, and advanced armor characteristics."

The "quick-change" feature of the Patton 48's high-velocity 90-mm. gun was shown when a crew from Aberdeen removed a weapon from the tank and substituted another 90-mm. gun in the field in a matter of minutes.

The Chrysler Delaware Tank Plant consists of five principal buildings, as well as other facilities, including a one-mile test track. Where a 240-acre tract of open field existed in January 1951 a bustling plant comprising more than a million square feet of floor space was in operation when the year closed. The first pilot model Patton 48 tank was completed December 14, 1951. The main manufacturing building in which the fabrication of parts and assembly of tanks takes place is a single-story structure of about 900,000 square feet of floor space—the equivalent of approximately 21 acres under one roof. Nearly 10,000 machines, fixtures, tools, and gages for the production of tanks have been installed in the main manufacturing building.

The program for this historic regional meeting was under the general supervision of Mr. Keller. Its expeditious presentation was under the direction of Milton Porter, assistant to Mr. Keller at the Newark plant, and the following staff members: Messrs. McDowell, Meier, Wright, Rogers, and Minett.

• **AT WASHINGTON.**—The board of directors of the Washington Post has planned an active and interesting program for the current season, including the selection of outstanding speakers and at least one visitation to a military installation of importance.

Board members include C. E. Meissner, Brig. Gen. Merle H. Davis, Stanley A. Shank, George M. Riveire, W. G. Lockwood, Dr. A. V. Astin, Dr. A. F. MacConochie, C. H. M. Roberts, George E. Engelmann, T. J. McCloskey, H. N. Arbuthnot, and Alfred H. Hobelmann.

For the first meeting, held in September in the South American Room of the Hotel Statler, qualified experts explained the scope of such electronic calculating machines as the "Maniac" or mathematical analyzer and numerical integrator and computer.

In a relatively short time such machines supply answers to complex engineering problems concerning highly involved and multitudinous mathematical calculations. They are finding an expanding use in industry and Government agencies, particularly in the field of calculating requirements for military items. The use of these machines is geared to the solution of problems where specific mathematical facts can be fed into them. Some advocates of the machines forecast that they eventually will be used to solve broad economic and social problems on a national scale.

The following speakers participated in the program: Dr. C. C. Hurd, director, Applied Science Department, International Business Machines Corporation; Ralph A. Niemann, U. S. Naval Proving Ground, Dahlgren, Va.; and Dr. Werner Leutert, Ballistics Research Laboratory, Aberdeen, Md.

• **AT NORFOLK.**—Led by Post president Ludlow King, the October meeting of the Washington Post featured a very interesting trip on the U.S.S. NEW JERSEY, one of the largest and latest type battleships, temporarily stationed at the Norfolk Naval Shipyard in Virginia.

Facilities were available for approximately 200 Post members, and hence it was necessary to handle this trip on a first-come, first-served basis.

Post members arrived at the Bachelor Officers' Quarters, Naval Air Station, Norfolk, Va., at 10:00 p. m., on October 15th.

The following morning at 5:30 a.m., they boarded the NEW JERSEY which put out to sea to engage in an exercise which included firing. Members arrived back at Norfolk at 4:00 p.m. and had dinner at the Commissioned Officers' Mess.

On Friday morning, October 17th, an early breakfast was served and Post members departed for the U. S. Naval Amphibious Base for a 2-hour tour. A visit was also made to the Naval Air Station. Luncheon was served at 11:30 a.m., and adjournment was at 1:00 p.m.

• **AT BOSTON.**—The Yankee Post arranged a "Come-and-See" meeting to give members an opportunity to observe at first hand the work and the needs of the U. S. Navy. The annual Post meeting on September 17th was therefore preceded by a guided tour of an aircraft carrier, the U.S.S. TARAWA, and a submarine, the U.S.S. GREELING.

These tours made it possible for Post members to note the operations and types of equipment required by the Navy in the production of which Post members could be of assistance.

To extend a knowledge of the Navy's operations beyond that available by visits to the two ships at the Boston Naval Shipyard, there was a showing of the official Navy film, "The Fleet That Came To Stay," together with remarks by officers and other personnel of the Navy. The film portrayed in dramatic detail the experiences of the Pacific Fleet during World War II and the manner in which it overcame countless difficulties.

The tours and movie were followed by a trip across the harbor by Navy tug to the Boston Naval Shipyard, Charlestown, Mass. Here an opportunity was provided for a tour of the U.S.S. CONSTITUTION—"Old Ironsides." Dinner was served in the Yard Restaurant and the annual meeting was called to order at 7:30 p.m.

New officers and a number of directors were elected. Harry A. Wansker succeeded Lynn H. Morse as president. The new vice-presidents are M. Edgar Fain, William J. Carroll, and Helge Holst. John C. Dieselman was elected secretary-treasurer.

The following members will serve as directors for three years: E. W. Miller, R. N. Greenwood, C. F. Carlstrom, John J. Brogan, and Elmer J. McVey. David Gilman will serve as director for two years and John K. Ames for one year. John J. Meyer was elected to fill the unexpired term of E. M. Gordon who resigned. Mr. Wansker will serve as representative to the National Council of the Association for one year.

A membership report indicated that the Yankee Post is in a flourishing condition. It has 72 company members and 1,490 individual members, or a total of 1,562 members.

In relinquishing the presidency of the Post, Mr. Morse was the recipient of expressions of thanks for his outstanding contribution to ordnance progress during his tenure of office.

• **AT WATERTOWN.**—The Yankee Post took part in a titanium symposium at Watertown Arsenal, Watertown, Mass., on October 8, 1952. This was the first presentation of the practical background, know-how, and shop practice accumulated on the new metal. The symposium was not intended to be a research conference; titanium was discussed in manufacturing terms.

Introductory remarks were made by F. Gorham Brigham, Jr., who served as chairman of the symposium. The first speakers were Lieut. Col. Thurston T. Paul, director of research, development, and engineering at Watertown Arsenal, who spoke on the subject, "Titanium Comes of Age," and Col. B. S. Mesick, commanding officer of the arsenal and coördinator of the Army titanium program, who discussed the industrial future of titanium.

Four speakers devoted their remarks to the availability of titanium. They included T. W. Lippert, W. C. Beck, Thomas E. Perry, and G. T. Fraser.

The day-long program also featured the following experts on various phases of titanium handling and fabrication: Norman L. Reed on titanium in ordnance; Richard J. Bullock on forging; J. Walter Gulliksen on cold-forming; George C. Keifer on surface treating and corrosion; Allan J. Rosenberg on welding; Gordon T. Rideout on grinding; V. Jamilkowski on tapping; Norman Zlatin on turning and milling; Dr. M. Eugene Merchant on fundamental facts regarding the machining of titanium; and Francis G. Tatnall on titanium as a new-products potential.

Luncheon was served at the arsenal. In addition to the Yankee Post, the titanium symposium was also sponsored by the Hartford-Springfield Post of the Association.

Lynn H. Morse, former president of the Yankee Post, was treasurer of the Sponsors Committee, and Stanley C. Hope, president of the Hartford-Springfield Post, was a member of the committee.

• **RAYCROFT WALSH**, a member of the Association's Council and brother of the late president of the Association, James L. Walsh, died in August after a brief illness.

A resident of West Hartford, Conn., he was vice-chairman and a director of the United Aircraft Corporation.

Commissioned an officer in the Coast Artillery Corps of the Army, Mr. Walsh served as a pilot in the Army Signal Corps during World War I and later was commanding officer of France Field in the Canal Zone. He became a fiscal officer in the Army Air Corps in 1925 and the next year resigned his commission as a major to enter business.

He was associated for a time with the McGraw-Hill Publishing Company in New York and with Cheney Brothers, silk manufacturers, in Manchester, Conn. He then became general manager of the Hamilton Division of United Aircraft. In 1940 Mr. Walsh was named vice-president of the corporation and in 1947 he was elected to the board.

• **ALLEN ARMSTRONG**, former president of the Lone Star Post at Fort Worth, Tex., and a former director of the Birmingham Post, died in August at Cedar Grove, near Natchez, Miss.

A resident of Mexico for many years, he returned to this country in 1937 as president of the newly formed Texasteel Manufacturing Company. During World War II the company was a substantial producer of mortar ammunition and also produced ammunition for the Navy. Mr. Armstrong subsequently became president of the Liberty Manufacturing Company. He helped to organize the Lone Star Post, maintaining an active interest in A.O.A. affairs after removing his residence to Natchez.

• **ANDREW JACKSON HIGGINS, SR.**, charter member of the Association and a director of the Louisiana Post, died unexpectedly in New Orleans, on August 1, 1952.

Mr. Higgins was a famed builder of beach landing craft. At the peak of World War II his plants were producing 1,000 boats a month. They turned out a total of 28,000 boats and ships for the armed services during the war.

At the time of his death, Mr. Higgins' company was engaged in building more than $61 million worth of cargo vessels, tugs, mine sweepers, aluminum bridge-building boats, and various developments of a classified nature for the armed services.

• **RONALD C. HANDS, SR.**, well-known secretary of the Empire Post, American Ordnance Association, a native of Bridgeport, Conn., and a resident of Rochester, N. Y., since 1919, died September 2, 1952, after a brief illness.

His Army career began before World War I, and he served during that conflict in the Office of the Chief of Ordnance, Washington, D. C., as a production officer. Between wars he served as adjutant of the 554th Engineers and with the 323rd Engineers and General Hospital 169.

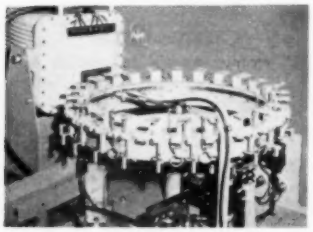
He returned to active duty as a major on September 2, 1940, as chief of the Industrial Division and chairman of the Contract Award Board of the Rochester Ordnance District until September 1946. From June 1947 until his death Colonel Hands was secretary of the Empire Post and a director of the Post from 1947 to 1951. At his death he was assistant to the president of Weber Machine Corporation, Rochester.

In February 1948, Governor Thomas E. Dewey conferred upon him the New York State Conspicuous Service Cross. He was a member and past commander of the Memorial Post, American Legion; chairman of the Military Affairs Committee of the Chamber of Commerce; a former adjutant of the Rochester Chapter, Military Order of the World War; a member of the executive committee of the American Society of Mechanical Engineers; and a past commander of the Knights of Pythias.

NEW DEVELOPMENTS

FUZE INSPECTOR

Many soldiers' lives will be saved by a new completely automatic hand-grenade fuze inspection machine, developed by General Electric's X-ray department, which utilizes extremely sensitive cadmium sulfide crystals as X-ray detectors and eliminates the danger of human error in inspection. An estimated $2,000,000-plus saving a year is projected by the use of those



Automatic fuze inspection machine.

units now on order if used on a 3-shift basis. This will be effected by eliminating the use of X-ray film, now employed in one hundred per cent inspection of the fuzes, and by a great reduction in labor time.

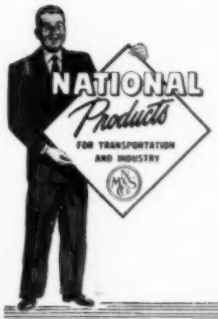
Rays from a 100,000-volt X-ray unit are directed through the fuzes as they pass between the X-ray tube and the crystal detector. If the time-delaying slow-burning powder is not packed in the fuze to the correct height, too much X-ray passes through the fuze and excites the valve-like crystal to the point at which it will pass current to actuate a mechanism that drops the defective fuze down a chute. Lack of enough of the time-delay element would cause premature explosion of the grenade, possibly in the soldier's hand.

ATOMIC PLANE ENGINES

Construction of facilities related to the eventual development of nuclear propulsion for aircraft has been authorized by the U. S. Atomic Energy Commission. The new facilities, estimated to cost approximately $33 million, will be built at the AEC's National Reactor Testing Station in Idaho. Construction is scheduled to begin this summer.

The nuclear phases of the project parallel the associated nonnuclear propulsion devices being developed under an Air Force contract. Support in nuclear design and development is being furnished by the Oak Ridge National Laboratory.

Castings by National
selected for Quality
and Dependability

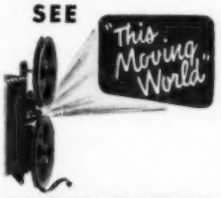


Products bearing these familiar trademarks have all established enviable reputations for quality and dependability. And to guard product reputations, these manufacturers *continue* to specify castings by National —one of the Nation's largest founders.

National's unparalleled experience in producing malleable, heat-treated malleable, and steel castings is at your disposal. Sales offices and engineering facilities are located at all five strategically located plants.

A-5858

PLANTS LOCATED IN Sharon, Pa., Cleveland 6, Ohio, Indianapolis 6, Ind., Melrose Park, Ill., and Chicago 50, Ill.



A 16mm technicolor film. Narrated by Edwin C. Hill, this 27-minute film tells how malleable iron is made . . . tested . . . used . . . how its production economy, ductility, machinability, toughness will give you a better finished product. Available for group showings.

NATIONAL
Products
FOR TRANSPORTATION AND INDUSTRY

NATIONAL MALLEABLE and STEEL CASTINGS COMPANY
CLEVELAND 6, OHIO
Est. 1868

No matter how you **FIGURE** *it:*

...you'll always have the right answer

with this

UNDERWOOD SUNDSTRAND 10-Key Adding-Figuring Machine

Right you are . . . getting your figure-facts from an Underwood Sundstrand Adding-Figuring Machine!

And *that* goes for the preparation of sales data, payrolls, stock records, invoices and practically any other figuring job in your business.

This machine is compact, precision-built . . . and equipped with *the world's fastest keyboard.*

Operation is *simplicity itself!* The 10 numeral keys are grouped under the fingers of one hand . . . and *anyone* in your office can quickly develop a smooth touch method. No tiring headswing.

What's more, the action of the machine itself is cushioned and quiet. Keys fit finger tips for increased keyboard accuracy.

The *price* is right, too! So don't wait any longer for the quickest, easiest figure-facts you ever had!

Ask for a demonstration of the Underwood Sundstrand Adding-Figuring Machine . . . *today.*

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New Developments

MISSILE TEST STATION

A $440,000 expansion of testing facilities at the Army Ordnance Corps' Malta missile test station has been scheduled for 1953, according to the General Electric Company which operates the installation.

The program calls for a new combustion laboratory, a water-filtering plant, an additional water source, and additions to one of the control rooms.

The test station has been in operation for more than five years and has contributed valuable data for basic rocket motor design and fuel development. Since its inception, the station has static-tested rocket motors as part of the joint General Electric-Army Ordnance guided-missile research program.

RADAR SIMULATORS

A contract for the construction of a number of radar simulators has been received by the guided-missiles division of the Fairchild Engine and Airplane Corporation. The equipment will be used in the training of radar operators for Navy jet interceptor aircraft under simulated tactical conditions. Used in conjunction with a flight simulator it will simulate the airborne radar of a jet interceptor.

The simulators are being produced for the Navy's Special Devices Center under a contract with the Office of Naval Research. The equipment will permit an instructor to "feed in" problems like those which would be encountered by the radar operator viewing his scope during an actual intercept mission. From the presentations appearing on his simulator scope the radar operator directs the pilot "flying" the flight simulator in the attack on the "enemy." Use of the radar simulator in conjunction with the flight simulator will permit coördinated crew training.

MOBILE FUEL TANK

A newly designed mobile petroleum tank intended as an auxiliary source of bulk petroleum supply by land or air is undergoing field testing by the Army Quartermaster Corps. Two experimental models of the 800-gallon tank were constructed for the Quartermaster Corps by the Martin-Parry Corporation of Toledo, Ohio. Drawn in tandem behind an Army truck, the tanks will be towed at high speeds over rough roads and terrain, loaded and unloaded in cargo aircraft, and studied for general usefulness and serviceability at the Army Quartermaster Center, Fort Lee, Va.

The tank is fastened to and removed from its chassis by use of a quick-clamping device. Twelve small wheels on each side of the tank facilitate its loading and unloading aboard an aircraft. The tanks from two or more units may be stacked upon each other for transport. However,

Cincinnati

THE TAFT MUSEUM
now a famous Cincinnati landmark was once the residence of Mr. and Mrs. Charles Phelps Taft. Built in 1820 when architecture was influenced by classic forms, this historic house merits the visitor's attention for its charm and authenticity.

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the original-Since 1901
engineered conveying systems

YOU CAN SEE THE SUPERIORITY OF A-F CONVEYOR ENGINEERING

Cincinnati is famous for many types of products — among which are A-F Engineered Completely Co-ordinated Conveying Systems.

A-F Alvey-Ferguson Engineers All Types of Conveying Systems For All Types of Industry

For a discussion of latest scientific handling methods write

THE ALVEY-FERGUSON COMPANY

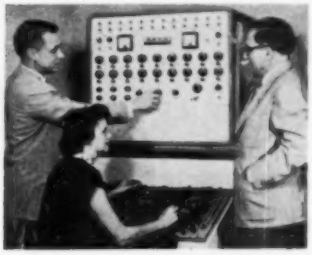
A-F 533 Disney Street Cincinnati 9, Ohio Offices in Principal Cities

the entire equipment, including chassis, may be transported by air.

A NEW COMPUTER

A new and improved "electronic brain" capable of working the most difficult and complex mathematical problems has been developed by Goodyear Aircraft Corporation, Akron, Ohio.

The L3, amazing new version of GEDA (Goodyear electronic differential analyzer) can solve in one hour scientific problems that would require as much as



The Goodyear differential analyzer.

500 hours of advanced computation by engineering specialists.

The analyzer solves problems in terms of voltages and wave forms, which are transcribed onto paper in allied recording machines and interpreted by trained technicians. Problems of direct simulation are answered through a study of electrical and mechanical circuits. By substituting different voltages in the L3 GEDA for the different parts of an equation, any problem of motion that can be translated into a mathematical equation can be solved.

NINETY BELOW

One of the coldest spots in the Nation is in the 60 foot-square polar laboratory in Cleveland, Ohio, newly built by Perfection Stove Company. Currently, company engineers and technicians are working in temperatures ranging from 70 to 80 degrees below zero. The laboratory temperature, however, can be brought down to as low as 90 degrees below zero.

Unique in private industry, this new 90-below cold laboratory ranks with those developed by the armed services for the cold-testing of combat vehicles and other equipment which must operate in polar regions. The cold laboratory was built at a cost of $250,000 to test the starting characteristics of internal-combustion engines, fuels and lubricants, metals, materials, and the efficiency of heating devices at temperatures ranging from minus 65 to minus 85 degrees Fahrenheit.

Walls of the cold chamber are insulated with 12-inch thicknesses of rock cork; the exterior, wall, and ceiling flooded with

OXYGEN
WHEREVER NEEDED

AIR FORCE
ENGINEER CORPS
ORDNANCE CORPS
CHEMICAL WARFARE
MEDICAL CORPS,
all have important needs for oxygen, met in combat areas by these mobile oxygen generators, manufactured by Air Products, Inc., Allentown, Pa.

Air Engineering by NIAGARA

has developed important components for these, as well as industrial systems involving the production and use of special gases, controlled atmospheres, control of moisture and heat in air and gases, heat transfer between gases and liquids, condensation of vapors and gases, heating, cooling, refrigeration, moistening, drying and treating air and gases for exact control of moisture.

If your process, material or product needs protection or improvement by a better control of atmospheric conditions, or if you require such controlled conditions for testing or production, your nearest Niagara Engineer has experience that can help you. Write to the Niagara Blower Company, Dept. O, 405 Lexington Ave., New York 17, N. Y.

INDUSTRIAL COOLING HEATING • DRYING
NIAGARA
HUMIDIFYING • AIR ENGINEERING EQUIPMENT

New Developments

asphalt. The ceiling is applied on top of transite-corrugated board supported by 4- by 8-foot wood beams.

The laboratory is refrigerated by three Brunner compressors hooked up in 2-stage system. Liquid F-22 (Freon) is the refrigerant. The entire system is controlled by one Brown recording temperature controller which is capable of maintaining the laboratory at the setting of plus or minus two degrees Fahrenheit. Practically every known precaution has been incorporated in the electrical control circuit to protect the system.

To facilitate the entry of large vehicles such as tanks and trucks, the 85-below laboratory has been constructed with a loading door 12 feet square. Six-light Thermopane viewing windows, 24 by 36 inches, permit a check on cold-chamber activities from the antechamber.

To protect technicians working in the laboratory an alarm system has been rigged up with control buttons placed at various points inside. Also, technicians may communicate with those on the outside by means of an intercommunication system.

RESEARCH ELECTRO-MAGNET

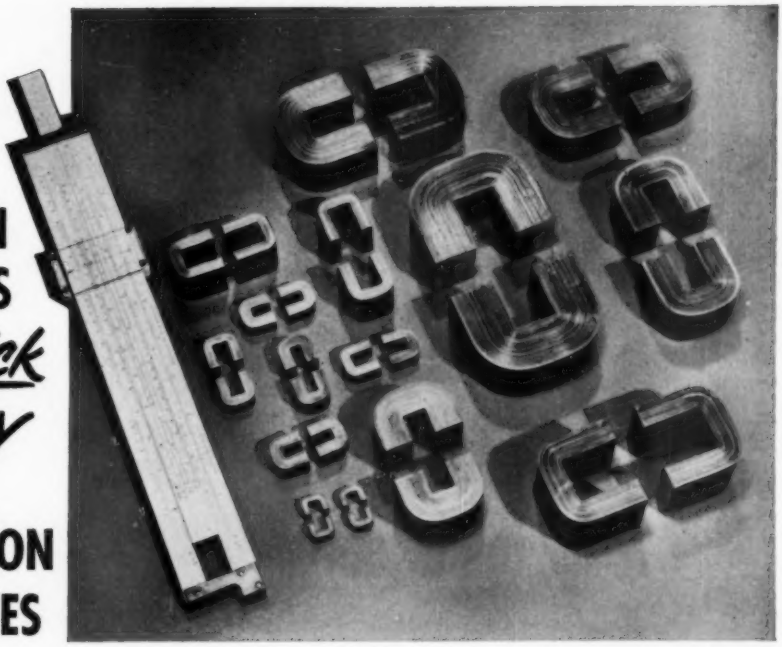
Magnetic fields as high as 40,000 gauss, or lower fields with extremely high uniformity, are provided by the new Model V-4012 Varian research magnet. Applications include nuclear- and paramagnetic-resonance work, Zeeman studies, and other research projects where relatively high volumes of high-homogeneity magnetic field are required. Under the standard arrangement with pole caps of 12-inch diameter and an air gap of 1¾ inches a magnetic field is produced which is uniform to one part in 50,000 throughout a cubic-inch volume of air gap. A maximum air gap of 5¼ inches is possible. For high-field studies tapered pole caps are substituted for the conventional flat ones. Having dimensions 41¼ by 36 by 52½ inches high, the magnet weighs approximately 5,600 pounds.

OXYGEN FOR CARRIERS

Oxygen plants, capable of making Navy aircraft carriers self-sufficient in providing oxygen for jet planes, have been developed under a Bureau of Ships program. In the past, carriers have been dependent upon shore bases or refueling ships for oxygen.

The oxygen plants were designed because of constantly expanding needs for high-altitude jet planes that operate from the large carriers. As a by-product, the plants also produce nitrogen, which is used to purge gasoline lines aboard the big ships. The plants produce 4.34 gallons of liquid oxygen (500 cubic feet of gaseous

SILECTRON "C" CORES *for quick delivery* IN PRODUCTION QUANTITIES



. . . wound from strip as thin as 0.00025"

Quality-Tested and Proved

- ★ Arnold "C" Cores are made to highly exacting standards of quality and uniformity. Physical dimensions are held to close tolerances, and each core is tested as follows:
- ★ 29-gauge Silectron cut cores are tested for watt loss and excitation volt-amperes at 60 cycles, at a peak flux density of 15 kg.
- ★ 4-mil cores are tested for watt loss and excitation volt-amperes at 400 cycles, at a peak flux density of 15 kg.
- ★ 2-mil cores are tested for pulse permeability at 2 microseconds, 400 pulses per second, at a peak flux density of 10 kg.
- ★ 1-mil cores are tested for pulse permeability at 0.25 microseconds, 1000 pulses per second, at a peak flux density of 2500 gauss.
- ★ ½ and ¼-mil core tests by special arrangement with the customer.

Now available—"C" Cores made from Silectron (oriented silicon steel) thin-gauge strip to the highest standards of quality.

Arnold is now producing these cores in a full range of sizes wound from ¼, ½, 1, 2 and 4-mil strip, also 29-gauge strip, with the entire output scheduled for end use by the U. S. Government. The oriented silicon steel strip from which they are wound is made to a tolerance of plus nothing and minus mill tolerance, to assure designers and users of the lowest core losses and the highest quality in the respective gauges. Butt joints are accurately made to a high standard of precision, and careful processing of these joints eliminates short-circuiting of the laminations.

Cores with "RIBBED CONSTRUCTION"* can be supplied where desirable.

Ultra thin-gauge oriented silicon steel strip for Arnold "C" Cores is rolled in our own plant on our new micro-gauge 20-high Sendzimir cold-rolling mill. For the cores in current production, standard tests are conducted as noted in the box at left—and special electrical tests may be made to meet specific operating conditions.

● We invite your inquiries.

*Manufactured under license arrangements with Westinghouse Electric Corp.

WAD 4211

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

No Missing Link Here

Deep in the Jungles "way back when"—
Apes made the FIRST "Rivetless Chain"

Apes have long been known to form "rivetless" chains. By the simple coupling process of linking tails they swing themselves out to cross streams and gorges.

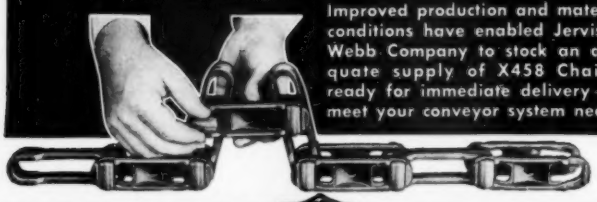
Drop-Forged Rivetless Chain another FIRST by JERVIS B. WEBB COMPANY

Proved by years of dependable service is the Drop-Forged Rivetless Chain, first developed by Jervis B. Webb Company for Trolley Conveyors. Simple and strong, it is cheaper and lighter per unit of ultimate strength than any other type of conveyor chain. It can be installed or removed by unskilled labor. Having no rivets, welds or bolts, it requires no special or joining links and may be disconnected at any point, yet it is so designed that it cannot become disconnected while in service.

The No. X458 Chain (illustrated below) is completely interchangeable with the Webb FIRST — the original No. 458 Chain designed in the early Twenties by Mr. Jervis B. Webb. X458 Chain has the improved webbed side link which substantially stiffens it, preventing telescoping while in service.

Need Conveyor Chain? **NOW**

We're In Position To Make
IMMEDIATE DELIVERY
X458 Drop-Forged Rivetless Conveyor Chain



Improved production and material conditions have enabled Jervis B. Webb Company to stock an adequate supply of X458 Chain — ready for immediate delivery — to meet your conveyor system needs.

CONVEYOR ENGINEERS AND MANUFACTURERS

JERVIS B. WEBB COMPANY

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DETROIT 4, MICH.

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oxygen) and 1,500 cubic feet of gaseous nitrogen per hour.

Production is accomplished exclusively by liquefaction and distillation of air from the atmosphere. The only necessary raw material, compressed air, is supplied either from the ship's high-pressure air system or from independent air compressors installed for the purpose.

NYLON BEARINGS

A new type of nylon-lined bearing has been developed by Thomson Industries, Inc., Manhasset, N. Y. These bearings consist of a thin, drawn-steel outer sleeve and a free-floating liner of Du Pont FM 10001 nylon.

Du Pont nylon is widely recognized for its excellent bearing characteristics, but

Cutaway view shows nylon bearing liner.

ordinary molded or machined nylon bearings have limitations due to the clearances required to allow for expansion due to temperature and moisture absorption, as well as distortion due to internal stresses. Also, plain nylon bearings cannot be press-fitted, and they usually use more nylon for structural reasons than is necessary for a bearing surface.

The new bearings were developed to offer a low-cost solution to these problems and to provide bearings of resilient material which resist poundout, decrease friction, permit dry operation, minimize abrasion failures, and damp mechanical vibration. They are corrosion-resistant and can be operated submerged in most liquids.

HIGH-FREQUENCY RELAYS

Multiple-channel microwave radio relays appear to be the "voice of the future" for replacing land lines in point-to-point communications circuits. Recently installed at Andrews Air Force Base, Washington, D. C., experimental equipment, operating in the frequencies above 1,000 mc. for rapid relay of teletype, voice, facsimiles, and other signals such as might be carried by wires, and connecting the world-wide Military Air Transport Service Communications Cen-

50,000 BTU's an hour

Model 1030

overall—physical size

Weight (lbs.)	23
Height (inches)	8-3/4
Length (inches)	16-5/8
Width (inches)	6-7/32
Installation space (ft³)	.523

1 engine pre-heating
Floods engine components, battery, crankcase, carburetor with hi-velocity warm, dry air. Makes starting easier, faster, positive—even at 65° below!

2 personnel heating
Warm air—plenty of it—independent of engine operation—circulates swiftly, evenly to keep personnel comfortable and more efficient!

3 windshield defrosting
Keeps windshield reliably "frost-free." Assures clear vision, safer driving at all times—completely independent of engine operation!

South Wind brings you all 3 with this...

compact new heater

● Never before has so small a heater afforded such wide application—*such amazing output of heat*—as this new South Wind heater. Now, this truly compact unit, designed to meet military specifications, is available to assure maximum vehicle and personnel efficiency under the most stringent weather conditions.

Versatile! Offers equal performance for trucks, stationary engines, air-cooled and liquid-cooled engines. **Powerful!** The most powerful heater for its size in the world with a useable output of 50,000 BTU's per hour! **Adaptable!** Burns gasoline, jet fuel or kerosene. Simplified operation! Easy to install! **Reliable!** Even under the toughest operating conditions, heat, and plenty of it, is assured—immediately!

Write Today for specific model information or experienced counsel on *any* phase of heating. Address inquiry to South Wind Division, Stewart-Warner Corporation, Indianapolis 7, Indiana.

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PERSONNEL HEATING
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industrial spray finishing equipment
engineered to your requirements

With Binks Material Handling Pumps, you deliver "heavy" materials—like sound deadeners, dopes, adhesives, buffing compounds, sealing compounds, rust preventatives, gear lubricants and many others heretofore considered impossible to pump—*directly from the original containers* to the spray guns or flow guns. You save up to 15% in handling time alone.

Moreover, only Binks Pumps offer the Surge Control, a new device that eliminates the annoying "spurt" of material when the operator first triggers the spray gun...gives you smoother coatings and saves expensive material.

Send today for manual 700
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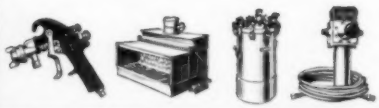


GUNS • SPRAY BOOTHS • MATERIAL TANKS • EXTRACTORS & ACCESSORIES

REPRESENTATIVES IN PRINCIPAL U. S. & CANADIAN CITIES • SEE YOUR CLASSIFIED DIRECTORY

ter with transmitter and receiver sites on the base, has proved itself efficient, economical, and virtually free from "bugs."

In present operation the system connects the remote high-frequency transmitter to the base Communications Center. Chief advantages of microwave systems near airports of the future are: (1) the elimination of wires as a hazard, (2) the multiplicity of transmission and reception possible on a single frequency (time-division multiplexing, using pulse-amplitude modulation can provide up to twenty-four 2-way voice channels), and (3) extremely economical operation (the power output required from the equipment was only one watt because of the 10,000 to 1 antenna gain achieved in the 6,000-7,000 mc. range of the microwave frequency spectrum).

Key to successful operation in the microwave frequencies is the efficient transmission of ultra high-velocity energies without excessive losses of energy through reflection or attenuation.

POWERFUL JET ENGINE

The Navy and the Westinghouse Electric Corporation have announced that Westinghouse has developed and placed in production the world's most powerful qualified turbojet aircraft engine. It develops thrust equivalent to approximately 25,000 horsepower at today's jet flight speeds.

The new power plant will be the first jet engine to provide constant speed drive for airplane accessories as an integral part of the engine. This feature will permit designers to make substantial savings in weight and space in new planes, both vital factors in aircraft superiority.

The new aircraft power plant has successfully completed the Defense Department's grueling 150-hour qualification test which all new engines must pass to be eligible for quantity production. The test was equivalent to more than 75,000 miles of actual flight, or three times around the world at the equator.

Several new fighter planes, all of which are scheduled for early production for the U. S. Navy, are expected to be powered by the new engine. These will include the McDonnell F3H "Demon" and the Douglas F4D "Skyray." The tremendous power of the new J40 is developed partly through the use of an afterburner.

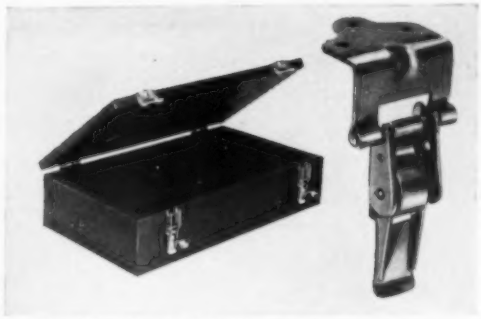
The new engine is of the axial-flow or straight-through design. Almost 25 feet long and about 40 inches in diameter, it is exceptionally light and produces more thrust per square inch of frontal area than any other turbojet. The engine is 2½ times as powerful as the combined four engines on a B-29 Superfortress, but its weight, approximately 3,500 pounds, is less than that of only one of the famous bomber's engines and propellers.

Have you a fastening or clamping problem?

IF YOU HAVE, CHANCES ARE BASSICK HAS A DEVICE TO SOLVE IT

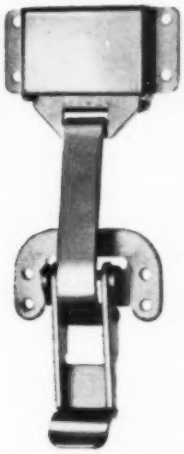
Catches and fasteners, for everything from jeep hoods to tool boxes, kits, and containers, are available from Bassick . . . either "standard", like the four shown, or adaptations to meet your special needs by Bassick development engineers working with you.

For many years, Bassick has been a leading supplier of specialty hardware to the automotive and other top industries . . . in addition to being the world's largest manufacturer of casters.



Combination Latch-Hinge (ZLA-1020, ZLA-1009)

A truly versatile fastener! Clamps on one side in locked position are acting as hinges, while the clamps on the other side are open, permitting entrance to the box, which can be opened from either side. Lid easily removed by unlocking all four fasteners.



Back View

"Power-Pack" (ZLA-1104)

This behind-the-catch view shows why this clamp won't loosen even under the roughest handling or vibration. There are *100 lbs. of tension* compressed in these springs, but it is not a "knuckle breaker"! Ideal for operation in sub-zero temperatures.

Flush Type Clamp Assembly

(ZLA-1098)

These clamps are fully recessed to allow close stacking of the crates, boxes, etc., on which they're installed. Arm is spring-loaded to work easily and grip the latch firmly. Hole for inserting padlock or shipping seal.

Heavy-Duty Hood Fastener

(C-4017)

"Catching" vehicle hoods is but one of the many uses for this type of fastener. It always provides a dependable and economical "hold", yet allows easy access to encased units. Bassick makes many sizes and styles.

Write for Specialty Hardware Catalog, showing our extensive line, or address your problem to THE BASSICK COMPANY, Bridgeport 2, Conn. *In Canada*: Belleville, Ont.

Bassick

A DIVISION OF STEWART SW WARNER

MAKING MORE KINDS OF CASTERS . . . MAKING CASTERS DO MORE

AMERICAN CHEMICAL PAINT COMPANY
AMBLER ACP PENNA.

Technical Service Data Sheet
Subject: PROTECTING ALUMINUM WITH ALODINE®

"ALODINE" No. 100

"Alodine" No. 100 forms an amorphous phosphate surface on aluminum which is thin, tough, durable, non-metallic, continuous with and a part of the basis metal. The "Alodine" film anchors paint, prolongs paint life, and protects aluminum exposed unpainted to the atmosphere.

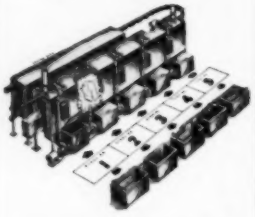
With the "Alodine" No. 100 bath at its normal temperature of 120° F., coating time by immersion approximates 1½ minutes—and by spraying, 15 to 20 seconds. Coating times and bath temperatures can be varied to suit operating conditions.

"ALODINE" No. 600

"Alodine" No. 600 forms corrosion-resistant coatings that provide excellent protection for unpainted aluminum and also make an effective paint-base. This grade is recommended for use in place of "Alodine" No. 100 on aluminum parts that are to remain unpainted or to be only partly painted; and on *all* aluminum castings and forgings whether or not these are given a paint finish.

"ALODINE" FLOW SHEETS

MULTI-STAGE POWER WASHER FOR SPRAY ALODIZING



IMMERSION TANKS FOR DIP ALODIZING

PROCESS SEQUENCE

1. Clean 2. Rinse 3. "Alodine"
4. Rinse 5. Final Rinse

NOTE: Equipment can be of mild steel throughout, except the "Alodine" stage which must be of acid-resistant material.

"Alodine" No. 600 is applied at room temperature (70° to 120° F.). Recommended coating times are 3 to 5 minutes for an immersion process and 1 to 1½ minutes for a spray process.

COATING DATA	"ALODINE" NO. 100	"ALODINE" NO. 600
COMPOSITION	Amorphous phosphate.	Amorphous mixture of metal oxides and chromates.
COLOR	Depending on alloy treated, color range is from an iridescent blue-green to a dark slate grey.	Depending on time of treatment, color range is from golden iridescent to light brown.
THICKNESS	From 0.01 to 0.08 mil. No appreciable dimensional changes occur when aluminum is Alodized.	From 0.005 to 0.01 mil. No appreciable dimensional changes occur when aluminum is Alodized.
WEIGHT	50 to 300 mgs. per square foot. Optimum: 100 to 200 mgs. per square foot.	35 to 50 mgs. per square foot.
SOLUBILITY	Insoluble in water, alcohol, solvents, etc. Insoluble in most dilute acids and alkalis. However, strong acids and alkalis which attack aluminum may penetrate the "Alodine" film and react with the underlying metal. Slightly soluble in concentrated nitric acid. Soluble in molten sodium nitrate, etc.	Insoluble in alcohol, water, solvents, etc. Soluble in strong alkalis and acids.
ELECTRICAL PROPERTIES	High dielectrical resistance.	This coating is electrically conductive. Aluminum coated with "Alodine" No. 600 can be shielded-arc welded or spot welded.
HEAT STABILITY	Unimpaired at temperatures that melt aluminum.	Unimpaired at temperatures that melt aluminum
FLEXIBILITY	Integral with and as flexible as the aluminum itself. Can withstand moderate draws.	Integral with and as flexible as the aluminum itself. Can withstand moderate draws.
ABRASION RESISTANCE	Approximately 98% of that provided by chromic acid anodized aluminum.	Approximately 98% of that provided by chromic acid anodized aluminum.
CORROSION RESISTANCE	Painted—superior to chromic acid anodizing. Unpainted—comparable with chromic acid anodizing. Meets MIL-C-5541 and other Government Finish Specifications.	Exceeds requirements of MIL-C-5541 and even AN-QQ-A-696a (anodic "clad")
PAINT BONDING	Excellent. Equal to or superior to anodizing. Meets MIL-C-5541 and other Government Finish Specifications.	Excellent. Meets MIL-C-5541 and other Government Finish Specifications.
TOXICITY	Non-toxic.	Non-toxic.
BIMETALLIC CORROSION RESISTANCE	Shows good resistance against bimetallic or galvanic corrosion.	Shows good resistance against bimetallic or galvanic corrosion.

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FROM THE RECORD

OUR COMPLEX AIRCRAFT

The modern fighting airplane must have communicating equipment, navigational equipment, compensated sights, provision for guns, rockets, and a wide variety of bombs, cockpit pressurization and air conditioning, equipment cooling, cockpit heating, radar equipment for night operations, power boost for the control surfaces, ejectable seats, in many cases heat deicing, and many other refinements.

The complexity and scope of these developments can best be described by the following few examples:

Five Tons of Air

To cool the Douglas F4D interceptor cockpit and electronic equipment at high speed at low altitude the air-conditioning systems must handle five tons of air an hour. This, however, won't even do the complete job. In addition, a refrigeration system is installed with a capacity equivalent to that required to freeze 176,000 one-inch ice cubes from 70-degree water in one day.

The heating system to heat the pilot and equipment in this airplane at high altitudes is capable of heating thirty 6-room average dwellings on a zero-degree-Fahrenheit day.

The aërodynamic forces on this same airplane are so great at high speed that a power control system is required approximately one hundred times greater than the normal pilot's effort. In other words, the control system requires approximately twenty-two horsepower . . .

400 Vacuum Tubes

In the F3D night fighter airplane the radar equipment alone weighs over 1,100 pounds and contains approximately 400 vacuum tubes. This equipment is 1½ times as heavy as the Wright brothers' airplane, including the airplane engine and pilot. This radar equipment is extremely complicated, but without the equipment the airplane could not operate effectively under all conditions.

This same airplane uses 6½ miles of electric wiring to connect its various components of electrical and electronic equipment. This does not include the wiring in the equipment units themselves.

In addition to the many essential military requirements there is another basic reason for the ever-increasing complexity. This is due to our psychology and is inherent to our way of life. The ingenuity and productivity of this mechanical age are reflected in very definite tendencies in

Users Report Big

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This adjustability and control of stroke length, ram speed and pressure assure further advantages. Tooling is easier to set up and change. Blanking dies get minimum wear for two reasons (a) Die impact is reduced greatly and (b) Pressure limits can be set only slightly above the force needed to shear the metal. This allows closer control of re-grinding and permits more grinds per die — slashing costs where they often pile up fastest. The 35-ton Multipress on this job is set for automatic cycling, to permit continuous manual feeding of pre-finished strip stock. Automatic stock feeds could also be used.

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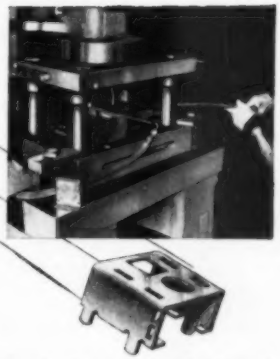

Typical part blanked and formed on progressive dies by Multipress, from .030 gauge pre-painted strip metal, at Modern Venetian Blind Co., New Bedford, Mass.

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From the Record

our every-day lives and in our thinking and our production. These tendencies are toward avoiding unpleasantness and expenditure of effort and toward providing ever-increasing safety.

Benefits Doubtful

The product of this trend has been more automatic devices, power devices, and safety devices—many of which, when added together and considered as a whole, result in doubtful benefits and frequently adversely affect the primary effort.

There is no question about it, the American military airplanes are in general the most complete and the best built in the world. Still, in many cases they have contained so much equipment that their performance and availability have been reduced to a point where their primary purpose and tactical usefulness have suffered.

Another way of expressing it might be to say that we are fighting a war with Cadillacs, whereas both World War II and the present Korean incident have shown that our enemies tend to employ stripped-down "hot rods."

Perhaps we are selling the pilot short. And it may well be that if we put our efforts into supplying aircraft with higher performance and less automatic or convenience features the pilot-airplane team would be more effective.

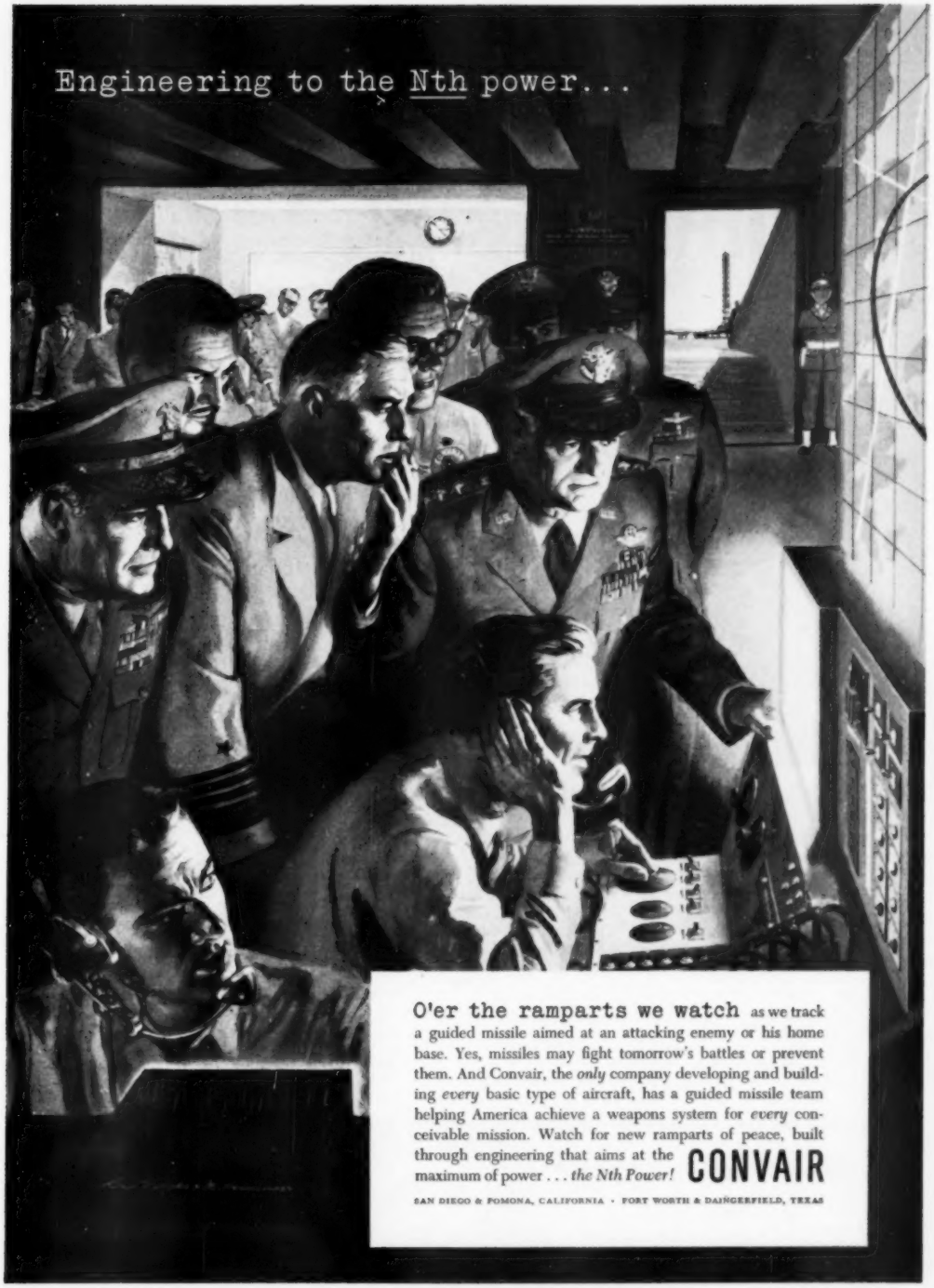
Much has been said about the recent trend in aircraft costs and ever-increasing budgets. War at best is inefficient and wasteful, and the best way to save this waste obviously is to avoid it. But when it can't be avoided we must make every effort to reduce this waste and cost to a minimum in order to prevent the shock of war spending from completely upsetting our peacetime economy for years to come.

Cost Due to Growth

Increased wages are, of course, responsible for a portion of these costs. The main increase in airplane cost, however, is due to its growth and complexity. For example, in the past 20 years the average fighter airplane has grown from a gross weight of approximately 5,000 pounds to the neighborhood of 30,000 pounds, with some fighters contemplated for production in the next few years running over 50,000 pounds.

About 20 years ago the average bomber's gross weight was about 15,000 pounds, while today it is averaging about 200,000 pounds. This increase in weight is partly justified by performance improvements, but it is doubtful that it is entirely justified.

Another way of expressing the recent trend in airplane costs is to consider that 20 years ago $100,000,000 would purchase


Engineering to the Nth power...
O'er the ramparts we watch as we track a guided missile aimed at an attacking enemy or his home base. Yes, missiles may fight tomorrow's battles or prevent them. And Convair, the *only* company developing and building *every* basic type of aircraft, has a guided missile team helping America achieve a weapons system for *every* conceivable mission. Watch for new ramparts of peace, built through engineering that aims at the maximum of power . . . *the Nth Power!*
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MOGUL

From the Record

approximately 1,000 fighters; today it purchases only about 100. In the bomber category, 20 years ago $100,000,000 purchased approximately 350 bombers; today approximately 20.

Designing a new airplane might be compared with trying to roll a snowball down a hill—without having it grow in size. It isn't easy. And when it comes to controlling cost, it is pretty much the same problem as balancing your home budget at income-tax time.

"Growth Factor"

This snowballing is commonly referred to in the industry as the "growth factor." For example, in the design of a current new model if a 100-pound item of equipment is added and performance and strength are maintained, the gross weight will increase—not by 100 pounds—but by a factor of 10—or a total of 1,000 pounds.

Multiply this 1,000 pounds by the national average cost per pound gross weight of airplanes constructed—which is $40 or better—and you will see that each 100-pound equipment item added will finally cost the taxpayer $40,000 more per airplane if performance is maintained.

The reason for this is that as equipment weight is added it is necessary to increase the wing area to maintain stalling speed, to increase horsepower to maintain high speed, to add material to the airframe to maintain strength, and to add fuel to maintain combat radius.

All these items must be pyramided in arithmetic progression, resulting in an average growth factor of 10 in present-day airplanes. Obviously, for small additions, the engine size and wing area are not increased; but in those cases performance suffers. . .

Engineer Needed

It is not possible for the pilot in combat, or even for the procurement agency, to analyze all airplane design requirements, to rationalize the many conflicting requirements, and to arrive at the inevitable compromises. This can best be done by the engineer. It is he who must analyze and piece together the many controlling requirements, find the suitable compromise . . . and, in turn, develop a superior article—by ingenious simple design rather than by extravagant design of the "snowball" variety.

Complexity is not a sign of perfection. Engineers are frequently lauded for the intricacy and complexity of their designs. This is a grave error. True perfection is a matter of solving problems by avoiding them and applying ingenuity to achieve simplification.—E. H. HEINEMANN, *chief engineer, El Segundo Division, Douglas Aircraft Company, before the National Society of Professional Engineers and the Chamber of Commerce, Tulsa, Okla.*

What it takes to silence a pillbox!

Steel: 90,000 lbs. Rubber: 1,800 lbs. Copper: 2,000 lbs. Bronze: 100 lbs. Specialized Personnel: 5

A single blast from a 105 mm. howitzer can reduce a pillbox to smoldering silence! This tremendous firepower is awesome... only a mount of great strength can withstand its recoil.

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BRIG. GEN. THOMAS K. VINCENT, *artillerist, engineer, author, Redstone Arsenal, Huntsville, Ala.*

Ballistics in the Seventeenth Century. By A. R. Hall. New York: Cambridge University Press. 186 pp. $4.

DR. HALL, a lecturer on the history of science, here presents for the student of ordnance a complete and scholarly treatment of ballistics in that critical period in which the traditions of the rule-of-thumb, free-lance gunner was being slowly replaced by the writings of scientists and the acquired skills of both English and continental "masters of the ordnance."

After a condensed but thorough review of science and technology as they impinged upon seventeenth-century ordnance, Dr. Hall records many details of gun founding, powder making, and artillery practice. The basic gunner's instruments of the time are illustrated, and a bibliography of source material of the early developments of science and mathematics aid the reader in following the study.

By digging deeply into the diaries and records, the author avoids ascribing too much credit to the burgeoning but still blundering scientific work of the period. Though he follows closely the groping progress of mathematics as it applied to ballistics, Dr. Hall shows that much of the scientific progress was the result of the questions arising from the empirical work of the gunner.

Gradually, however, ballistics theory so far outstripped ordnance technology that there was no opportunity for its application. Thus it was only when the engineering ingenuity of the nineteenth century wrought notable improvement in ordnance construction that ballistics was able to demonstrate most of its inherent importance.

The work is a critical study—by no means easy reading—but it is richly rewarding to any student of ordnance or of warfare. The author has performed a distinct service in evaluating the link between pure and applied science.—F. W. FOSTER GLEASON.

Now It Can Be Told. By James Gleeson and Tom Waldron. New York: Philosophical Library. 188 pp. $3.75.

SEVEN events of the war are here told in full, expanded from the radio scripts which were used to dramatize them. The dialogue is real and entertaining. These stories, with the exception

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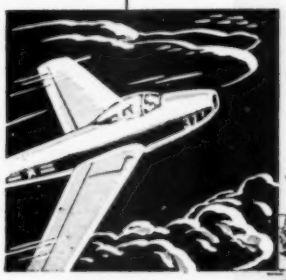
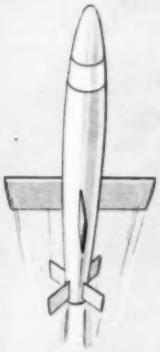
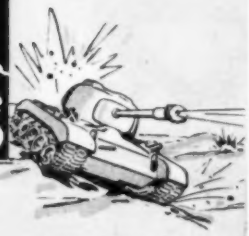


Knowing your whereabouts under all circumstances



Controlling guided missiles in flight



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Shooting down jet planes from the unstable decks of ships

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Take one part of the fantastic, mix thoroughly with Ford's engineering and production ability, and you've got the answer to another "impossible" automatic control problem. That has been the sum and substance of the Ford Instrument Company since 1915.

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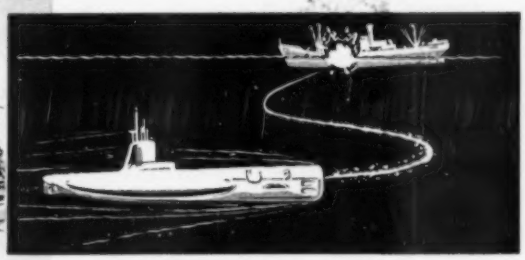

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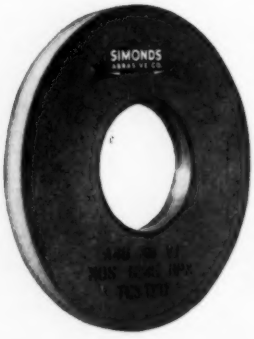

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of the secret adventure of Gen. Mark Clark in preparation for the landing in Africa, cover episodes of British operations and action, with British principals.

Whether discussing individual or collective endeavors, the authors have unmistakably conveyed the spirit of determination and self-sacrifice so essential to success in war. These stories are most interesting and should be an "inspiration for us all, and do but justice to the gallant, late though they be."—THOMAS K. VINCENT.

The World in March 1939. Edited by Arnold Toynbee and Frank T. Ashton-Gwatkin. New York: Oxford University Press. 546 pp. $9.

HITLER'S entrance into Prague on the evening of March 15, 1939, was the climax of German territorial aggression during an agonizing period of formal peace. For five years Nazi Germany had dominated and terrorized Europe, in widening circles, without beginning a war. Hitler's chalet at Obersalzberg had been the center of European diplomacy, as once were the monastery of the Escorial and the palace of Versailles.

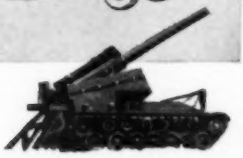
Like Philip II's occupation of Portugal in 1580, and Louis XIV's seizure of Strasbourg in 1681, the German annexation of Bohemia and Moravia was the last expansionist triumph of a great power before the tardy arrival of a concern to preserve the balance of power produced a grand alliance in counterpoise and led to global hostilities.

It may be objected that the choice of any precise date to mark the outbreak of World War II is an arbitrary distortion of truth, even though it may be a necessary convenience. Yet few historians will deny that the destruction of Czechoslovakia marks a decisive turning point in history and offers an instructive field of vision to the student of international affairs who pauses to look around him.

The current volume, an introduction to the history of World War II in the Survey of International Affairs series, offers authoritative guidance to those who may want to make such a pivotal survey. The present study is divided into three parts of unequal length. The international situation in March 1939 is looked at first from a political and then from an economic angle of vision (Parts I and II), while the brief concluding section (Part III) sums up the unstable and already tottering balance of power and the ideological controversy in which it found expression.

In the international arena in March 1939 there were two separate areas of tension and conflict—one created by Japan and the other by Germany. In this volume these are dealt with separately in two different subdivisions. *(Cont. p. 480)*

They do a better job



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Eclipse-Pioneer has long been the leader in developing similar electrical equipment for the aviation industry. This unique know-how plus production facilities unexcelled in its field enabled Eclipse-Pioneer to take the lead in developing and manufacturing the new, more efficient electrical equipment for Army track vehicles.

Possibly you have problems pertaining to electrical systems or components. If so, we'd welcome the chance to counsel with you about them . . . and to put our development and production facilities to work in helping you solve them.

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Rockwell Report

by **W. F. ROCKWELL, JR.**
President
Rockwell Manufacturing Company

THE NEWEST PIECE of Rockwell capital equipment is a Sikorsky helicopter. The purchase order was placed after it met the same test we apply before buying any new equipment—how soon will it pay for itself? Since we have seven plants within a 200 mile radius of our headquarters, and since many of them are in small communities not easily reached by regular transportation lines, valuable time was lost in getting engineering and operating executives from plant to plant. The helicopter will operate on a regular schedule between plants, in each case landing a few minutes from the factory door, where standard aircraft would be forced to land miles away.

Now, specialized management counsel is only hours away from each of these plants. Overhead savings will be substantial and the plants will have more frequent and direct contact with all of the Rockwell headquarters staff.

* * *

Our Delta Power Tool Division is putting on the market a new combination tool that is a whole homeworkshop in a single unit. It requires less than a three-foot square area, and a single motor is all that is needed. Actually, it is a full-size Delta Homecraft tilting arbor circular saw, drill press, jointer and sander ingeniously combined in a single mounting. It is the only combination home workshop tool that is made up of complete machines rather than loose attachments.

As a consequence, it can be separated into individual tools if the buyer wants to start out with a very small, compact workshop, and then has room or wants to expand his homeshop later on. It is built around the four basic woodworking operations—sawing, planing, drilling, and finishing or sanding. It was designed so that it isn't necessary to spend a lot of time changing from operation to operation. For instance, if you saw a board, you would normally next plane the edge. So the saw and jointer are side by side, ready to use without set-up.

We think the Deltashop will get an enthusiastic welcome from homeworkshop fans and from householders who want power tools to make normal home repairs and improvements, especially for those in small homes and apartments where space is limited.

* * *

The design of a steam power plant, petroleum refinery, chemical plant or other process unit involves the specification of thousands of valves. Making up a list of required valves is often a complex and tedious job, because of the wide variety of requirements by size, pipe connection, materials, flow pattern and many other considerations.

Both of our valve divisions have made great strides in simplifying this job for consulting and plant engineers. Our Nordstrom Valve division has developed a Refinery Specification Manual for the petroleum industry, and our Edward Valve division has published a Valve Guide for Power Plants. Both books key the correct valves to each service in a master flow diagram. Nordstrom or Edward sales engineers, as the case may be, will be happy to review these manuals with interested engineers.

* * *

It is a policy of the Rockwell Manufacturing Company to encourage department heads to belong to and participate in useful trade or technical associations in their own fields. Association membership can take a lot of time, and therefore we expect a reasonable return in one of several ways. We ask these questions of our people about their association activities: Does it help you keep up-to-date with new technological developments? Is the association broadening the market for our products and services? Does your association have clearly defined objectives to which we, as a company, should subcribe? Are you more effective in your job as the result of your association work?

There is a tendency today, we believe, to start societies and trade groups on rather thin purpose, and many useful ones thereby lose stature. Business needs many of these groups, and a check by each company on the usefulness of its memberships will help keep associations on a definite track.

One of a series of informal reports on the operations and growth of the
ROCKWELL MANUFACTURING COMPANY
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for its customers, suppliers, employees, stockholders and other friends

Book Reviews

Within each of these subdivisions the countries in danger of being attacked are surveyed in an ascending order of peril—starting with those at the outer limits of the regional aggressor's range of action, going on to those that found themselves within point-blank range of his batteries, and concluding with a picture of the aggressor power itself.

The economic survey (Part II) is focused on the great powers, and it has been found possible here to draw a broad picture without subdividing the map of the world in such detail as in the political panorama.

The editors and their distinguished associates have done a superb job of objective interpretation and analysis. The book is an outstanding contribution to a mature understanding of the global crisis of the twentieth century.—JOHN J. O'CONNOR.

The Gun Digest: Seventh Edition, 1953. Edited by John T. Amber. Chicago: Wilcox & Follett. 224 pp. $2.

ALWAYS significant for the small-arms enthusiast, this 1953 edition of a well-established firearms annual adds to its complete information on arms and their prices more than twenty-five articles on related subjects. They are written by such experts as Charles Askins, Townsend Whelen, Maj. Gen. J. S. Hatcher, Phil Sharpe, and Walter Roper. They run the gamut from European proofmarks to the new U. S. and British automatic rifles which have caused so much recent controversy (adding much light to the plentiful heat!).

Beside the regular sections dealing with rifles, shotguns, and handguns, such items as sights, scopes, cartridges, antique arms, foreign guns, and handloading are treated. Stephen Grancsay contributes an article on some rare museum pieces. Rarely is such an enormous subject so well covered—necessarily with many gaps—but with something of real value to any "gun bug" and plenty of interest and entertainment to any and every man who likes firearms. —F. W. FOSTER GLEASON.

The Standard Manual of the Slide Rule. By J. E. Thompson. New York: D. Van Nostrand Co. 216 pp. $2.75.

THE second edition of this admirable work will doubtless be welcomed not only by the many students and teachers who have found it helpful in the past but by others making its acquaintance for the first time. Dexterity with the slide rule is an accomplishment which even some engineers never fully acquire, to their own detriment in loss of time and efficiency.

This has arisen in the past from the failure of the schools to take more than a casual interest in training the pupil in its

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use. The simplicity and clarity of this work should be an encouragement to both student and mentor alike to take the slide rule more fully into their confidence.

The first chapter, which deals with the history of the slide rule, especially caught this reviewer's eye. To the adolescent, the impersonality of mathematics is sometimes a repellent force, for which the remedy is humanization in terms of personality. For example, the all-too-brief reference to John Napier, eighth Napier of Merchiston, Edinburgh, who flourished in the latter part of the sixteenth and early part of the seventeenth centuries, is particularly delightful. The author quotes from Napier's announcement of the discovery of logarithms as follows:

"Seeing there is nothing, right well beloved students of mathematics, that is so troublesome to mathematical practice, nor doth more molest and hinder calculators, than the multiplications, divisions, square, and cubical extractions of great numbers which, beside the tedious expense of time, are for the most part subject to slippery errors. . ."

Could anything be more effective in dispelling a common adolescent notion that mathematicians as a class are troublemakers who have taken a delight in making life more difficult for ordinary mortals! The writer recalls a master in his old school in Edinburgh, known affectionately as "Mathy Mat"—his real name has long since been forgotten—who had a real genius for bringing the teaching of his subject within the orbit of human relations.

The tedium of the hour would be relieved on appropriate occasion with some little anecdote, long remembered after the lesson itself had become submerged in the generality of intellectual capacity, happily associating the man and his work.—ARTHUR F. MACCONOCHIE, *head of the department of mechanical engineering, University of Virginia, Charlottesville, Va.*

The Middle East. By W. B. Fisher. New York: E. P. Dutton & Company. 514 pp. $5.75.

SINCE the Middle East is currently one of the most important geopolitical arenas on the globe, timeliness is the keynote of this book.

Dr. Fisher covers the region bounded by Cyrenaica, Turkey, Iran, and Saudi Arabia. For heterogeneity, this crossroads has few equals. But under the experienced and objective analysis of the author, a professional geographer and lecturer at the University of Aberdeen, it assumes a degree of coherence.

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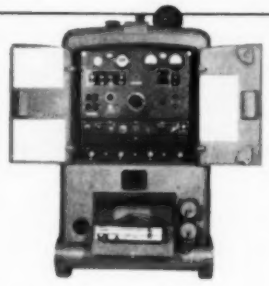

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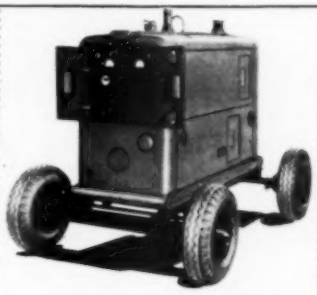
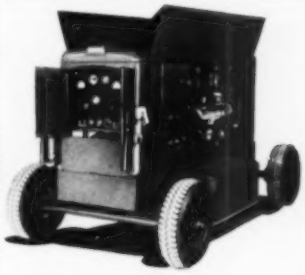
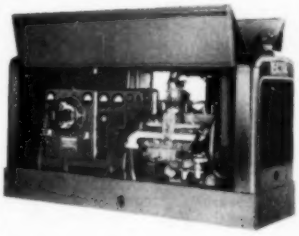


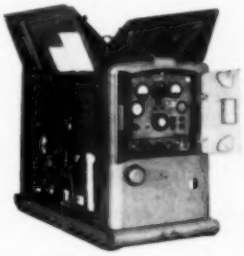
Model 675G7AH. 400 cycle, high frequency, gasoline engine driven generator. 3, 5, 10 and 30 KW cap.



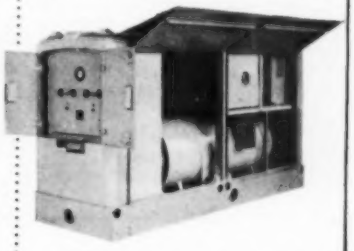
Model 595. 600 ampere, 28.5 volt, gasoline engine driven, trailer mounted aircraft energizer.



Model GR315SS. 300 amp., gas engine driven DC arc welder with 3 KW Auxiliary Power Generator.



Model JB5AC. 60 cycle, gasoline engine driven, AC generator set. 5, 10, 15 and 30 KW capacities.



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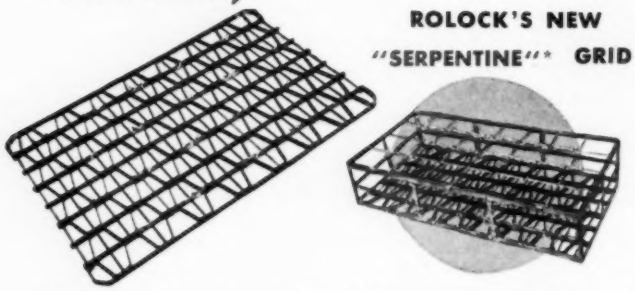

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Versatility of application is shown above. Inconel tray with positioning lugs used for copper brazing taurus assemblies at 2050°F. Basket, also of Inconel, used for annealing, quenching, and acid pickling steel components in a continuous cycle. Full details on application.

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Book Reviews

simmering cauldron accompanies the purely academic approach necessary to a text of this kind.

In addition, there are ninety-three maps, and the appendices include an outline of the geological history of the Middle East, temperature distribution in the atmosphere, a glossary of geographical terms which will make sense of many foreign map names used, and an extensive bibliography.

As geography is basic to an accurate appraisal and understanding of world problems, this text should appeal to serious students of global relationships.—ROBERT E. LA RUE.

Battle Casualties. By Dr. Gilbert W. Beebe and Dr. Michael E. de Bakey. Springfield, Ill.: Charles C. Thomas. 257 pp. $10.50.

I HAVE read this volume with much interest. In my opinion it is a very worthwhile analysis and presentation of statistical data dealing with battle casualties.

The authors have pointed out in a very clear way certain fallacies in past reports dealing with mortality and morbidity figures in battle casualties. They also have pointed out methods to overcome these deficiencies.

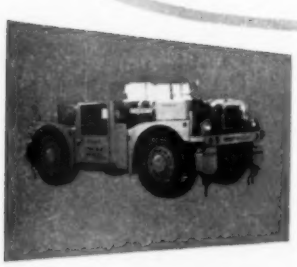
The volume is a very useful reference for professional, educational, and operational planning purposes. I recommend it for careful study by all medical officers, and particularly recommend that it be placed in reference libraries everywhere in military establishments.—MAJ. GEN. PAUL H. STREIT, *commanding officer, Walter Reed Army Medical Center, Washington, D. C.*

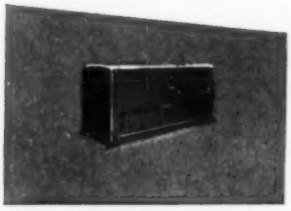
The Military Electronic Study. By William C. Urlovic. Oakland, Calif.: Published by the author. 23 pp. Free.

WHILE this booklet is directed toward a presentation of the problems involved in a military electronic study, it nevertheless offers an excellent guide to the planning, organization, and initiation of a contract study on any military problem. Its analysis of the requirements and suggested procedures should be most helpful to every organization entering the field without previous experience and to most who have experience but have not yet found the key to fully successful performance.

The analysis of the contractor's problem also should prove a useful guide to those concerned with study contracts on the Government side. It indicates by implication contractual arrangements, including costs, which must be covered in establishing reasonable opportunity for successful

if it's worth starting...





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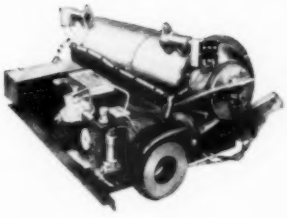

If you want to make sure that a military or commercial vehicle is fully equipped to start and function over the entire range of operating conditions—right down to 65°F below zero—write *Janitrol liquid heaters* into the specifications. Recent tests under the severest operating conditions have proved beyond question that the new 90,000 Btu-per-hour capacity Janitrol liquid heaters insure positive starting without special fuel capsules—at minus 65°F after a 72-hour cold soak. On the A-2 bomber towtug, for instance, in 65°F below zero weather the engine can be started and the towtug rolling well within 30 minutes after heater is switched on—or the heater can be used to raise the engine temperature to 160°F and maintain standby warm engine and operating parts in any weather. In addition to assuring *all-weather operation* Janitrol liquid heaters extend engine life and cut maintenance by preventing sludge formation and other deteriorating effects resulting from low operating temperatures. Call your nearby Janitrol representative for prompt help on any automotive or aircraft heating requirements.

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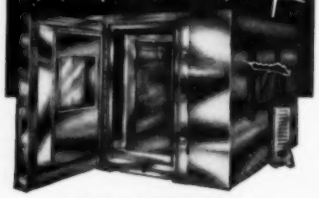

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Book Reviews

accomplishment of what is, frequently, a difficult task. The contractor will be especially benefited by careful perusal of the sections entitled, "Future Proposals," "Choice of Personnel," "Working Conditions," and "Suggested Attack on Military Studies."

Success in a study project is inherently wrapped up in the choice of a suitable staff and in its being set up under working conditions which permit most effective utilization of the full capabilities of high-caliber technical workers.

The plan of attack on a military problem given in the closing paragraphs comprehends the essential steps and provides an excellent guide to the organization of a military study for any one who has not had the opportunity to learn the technique from experience.—E. L. Rose, *senior engineer, Redstone Arsenal, Huntsville, Ala.*

Biography of an Idea. By John Bainbridge. New York: Doubleday & Company. 381 pp. $4.

THIS factual and highly interesting book is the story of mutual fire and casualty insurance in America. It starts with the great fire in London and the idea dreamed up by an eccentric London doctor, Nicholas Barbon. Ironically his company failed, but the idea of mutual insurance caught on.

Two hundred years ago in Philadelphia, Benjamin Franklin introduced mutual fire insurance into America with the formation of the still existent Philadelphia Contributionship for the Insurance of Houses from Loss by Fire. Today there are more than 4,000 other mutual companies.

This book is timely, since the two hundredth anniversary of the successful establishment in America of the institution of mutual insurance is now being celebrated. It is the means whereby, in the words of Franklin, "every man might help another, without any disservice to himself."—T. K. Vincent.

The Shoals of Capricorn. By F. D. Ommanney. New York: Harcourt, Brace & Company. 322 pp. $4.

THE ninety-two Seychelles Islands, 500 miles off the east coast of Africa, are the locale of this book. The author traveled about them for two years, covering 20,000 miles of some of the loneliest ocean areas.

The purpose of this lengthy voyage was to determine the commercial fishing potentialities of the region; it was hoped that the sole economy, copra, might be enlarged upon.

And to Mr. Ommanney, hats off! He has a singular talent for successfully transporting his reader into the midst of the shoals he came to know so well. It's a wonderful chance for all who want escape.—Robert E. La Rue.

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Book of the Month for November

Theodora and the Emperor

By Harold Lamb

THEODORA and her famous husband, the Emperor Justinian, ruled the Byzantine Empire in the sixth century—ruled it strongly and well. Under Justinian and Theodora the sweeping campaigns of the great Belisarius cleared Africa and Italy of barbarian pressure, and the strength they stored up for the "Eastern Rome" held back the Oriental for ten centuries. Here, as only Harold Lamb could write it, is the biography of two great rulers and the whole sweep of Byzantine history. Retail, $4.50.

To Members, $4.05

SPY-CATCHER

By Oreste Pinto

Col. Oreste Pinto is a former Dutch officer and an expert in counterintelligence. He was in charge of screening the thousands of refugees who fled into England after the fall of France, and was later in charge of Dutch counterintelligence after the invasion. In this book he tells about his most famous cases, including that of the Dutch Resistance "hero" who betrayed the Arnhem parachute drop. "Spy-Catcher" is fascinating reading—and a very practical manual of counterintelligence. Retail, $2.75. To members, $2.47.

U. S. FIGHTING PLANES: 1952

By Lieut. Col. Dale W. Cox

Here are the 24 newest fighters and bombers of the defense services. There are jets, turbo-props, and combinations of both power plants. Each plane is shown in silhouette and photographs, its major characteristics listed, and is described in a short text. Retail, $2.00. To members, $1.80.

BALLISTICS IN THE SEVENTEENTH CENTURY

By A. R. Hall

Mr. Hall considers the earliest developments in ballistics at a time when rule of thumb of the gunner began to give way to the mathematical approach. He records gun founding, powder making, and artillery practice of the time. Retail, $4.00. To members, $3.60.

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Vol. III: The Great Depression, 1929-1941

Mr. Hoover deals in great detail with the five stages of the United States depression and describes the failure of the Administration from 1932 to 1940 to achieve normal domestic recovery. He argues that the bank panic of 1933 was the most unnecessary in history, that the steps taken by the New Deal to restore prosperity resulted only in a turn toward collectivism. Whether or not you agree, you'll find in this book the sincere, forthright beliefs of a great American. Retail, $5.00. To members, $4.50.

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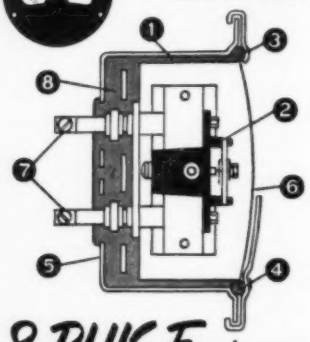

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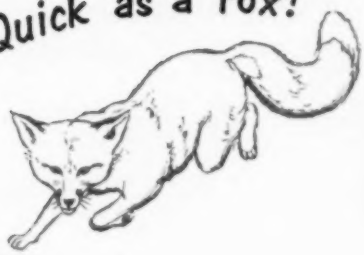

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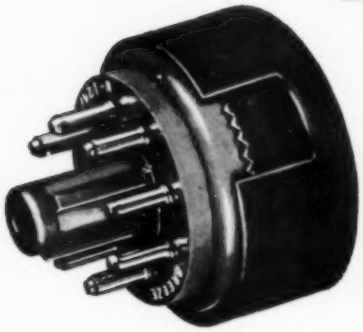

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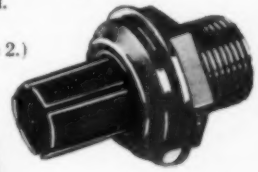
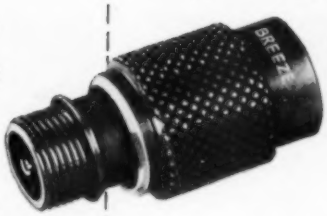
Quick Disconnect

Simply push male and female members together and lock. To disconnect with minimum resistance, pull back sleeve on plug shell and disconnect. Exceptionally low disengaging force required (less than 6 lbs., excepting pin friction). Vibration proof, moisture-proofed with synthetic rubber insert. Meets AN pin pattern and voltage requirements, in accordance with MIL C-5015. Plug shell and coupling sleeve are aluminum alloy, cadmium plated and iridite-sealed. (Federal Spec. QQP – 416, Type 2.)





Receptacle Types: Round flange single hole panel-mounted, square flange for 4 bolts, or specially flanged to specification. All contacts silver plated.

We invite your inquiries on any problems concerning connectors. Our wealth of engineering experience in this specialty is at your service.

BREEZE
CORPORATIONS, INC.
41 South Sixth Street, Newark, N. J.

You can't stop a gusher with a bottle cap

You can't stop corrosion with ordinary paints . . .

it takes BITUMASTIC COATINGS!

CORROSION can't be stopped by ordinary paints or conventional protective coatings. They can't protect surfaces against the ravages of rust for any appreciable length of time.

But Bitumastic Coatings can!

Unlike maintenance paints, Bitumastic® Protective Coatings are specially formulated from a base* of coal-tar pitch that is, for all practical purposes, impervious to water. When you keep moisture away from an exposed surface, you *stop* corrosion.

Bitumastic Coatings provide an extra-tough, extra-thick barrier against corrosive elements—a barrier that is impenetrable. And these coatings provide up to 8 times the film thickness of conventional paint coatings.

Bitumastic Coatings stop corrosion caused by moisture—acid fumes—alkaline fumes—corrosive soil—salt air—heat.

**Hi-Heat Gray contains a metallic base.*

There are 6 Koppers Coatings—formulated to control corrosion of metal and deterioration of concrete. Use the coupon for full information.

SEND FOR SET OF FREE BOOKLETS!

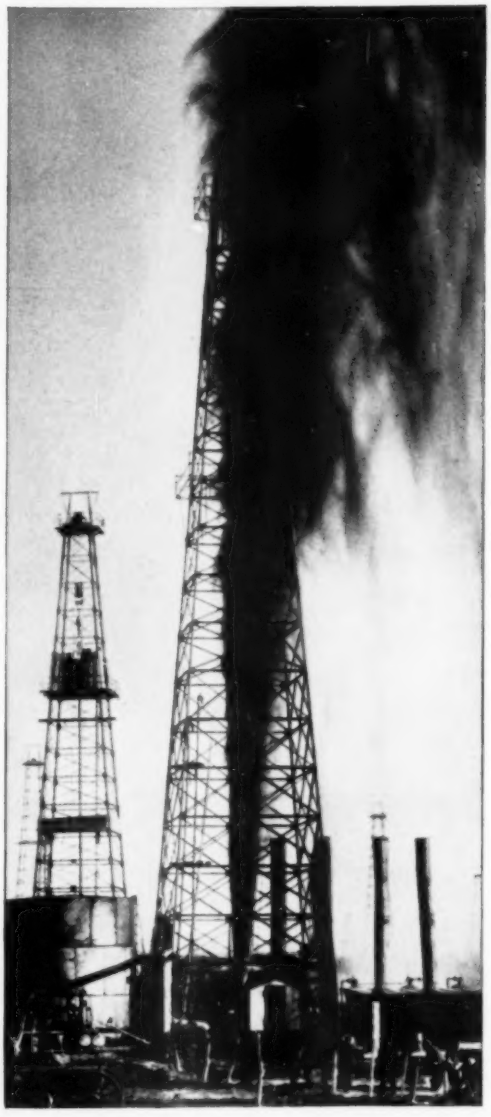
Koppers Company, Inc., Tar Products Division
Dept. 1170T, Pittsburgh 19, Pa.

Please send me, without charge or obligation, your booklets on corrosion prevention.

Name.....

Address.....

City.....Zone....State.....



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REG. U.S. PAT. OFF.

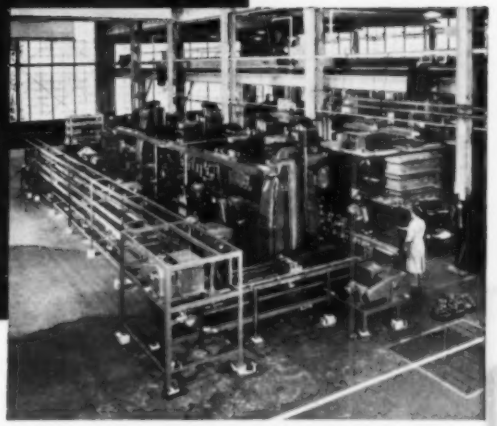
SOLD THROUGH INDUSTRIAL DISTRIBUTORS

KOPPERS COMPANY, INC., Tar Products Division, Dept. 1170T, Pittsburgh 19, Pa.

DISTRICT OFFICES: BOSTON, CHICAGO, LOS ANGELES, NEW YORK, PITTSBURGH, AND WOODWARD, ALA.

Ordnance Equipment by W. F. & JOHN BARNES

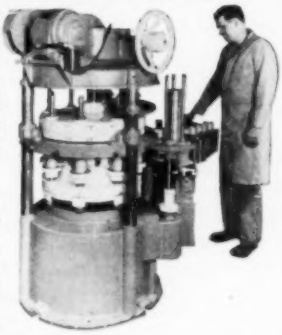
Here are only a few of the pieces of equipment built by W. F. and John Barnes for ordnance. In addition to many other individual pieces we have designed and built an entire plant for the automatic production of 155 mm high explosive shells. Other projects of a similar magnitude are now in progress. We will be glad to work with you on any machining or processing problems pertaining to ordnance.



Fast, Efficient Double Seamer

Here's a new closing machine (double seamer) that features simplicity of adjustment, fast operation and identical seams. Its speed of operation is limited only by slower operating equipment in the line. It has a minimum of parts, resulting in low maintenance costs and requires comparatively little floor space.

FEATURES of this new machine include a single adjustment for obtaining uniform seams consistently, moderate spindle speeds which eliminate "bounce" over side seams, and insure positive sealing. In addition, the design of the end feed makes it possible to take a wider variation in end sizes.

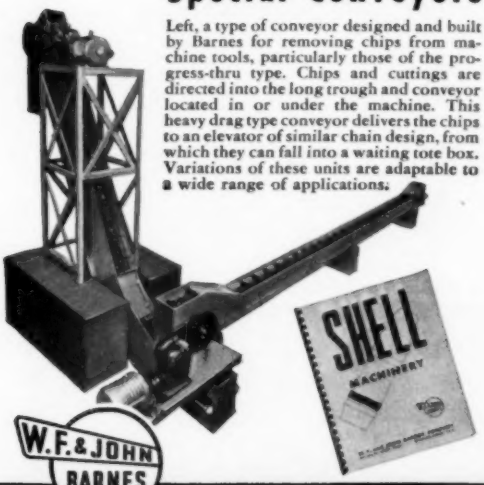


High Production Transfer-Type Machines

Above, many progress-thru type machine tools employ fixtures which must be returned to the loading end of the machine, and this special Barnes conveyor is built to accomplish this purpose automatically and in time with the cycle of the machine. The machine itself, and all its hydraulic equipment and control circuits are also Barnes products. This 24 station machine performs 116 operations automatically on compressor frames.

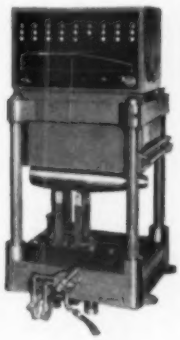
Special Conveyors

Left, a type of conveyor designed and built by Barnes for removing chips from machine tools, particularly those of the progress-thru type. Chips and cuttings are directed into the long trough and conveyor located in or under the machine. This heavy drag type conveyor delivers the chips to an elevator of similar chain design, from which they can fall into a waiting tote box. Variations of these units are adaptable to a wide range of applications.



Electrical Controls and Checking Equipment

Complete electrical circuits and controls have been designed by W. F. and John Barnes for a wide variety of installations. Shown to the right is an electronic gauge which simultaneously checks 9 significant dimensions on a 155 mm shell. Signal lights instantly indicate "over", "under", or "within limit" for each gauging point.



Free Additional Data

is available on all Barnes Ordnance equipment. Since it is impossible to give the complete scope of operation in this restricted space, we invite you to write for the complete Barnes Ordnance book. Ask for bulletins 0-1152

W. F. and JOHN BARNES

PROGESS EQUIPMENT DIVISION 320 SOUTH WATER STREET, ROCKFORD, ILLINOIS

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We can offer you experience and production know-how in producing hundreds of different items essential to defense. Shown are some of the many items that Precision has produced in quantities from a few thousand to many millions.

Since 1909 the name "PRECISION" has been the symbol of highest quality in the die casting industry.

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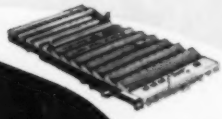

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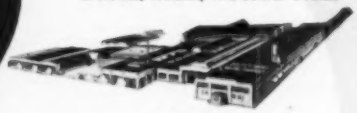
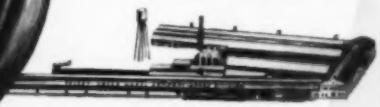
Kelsey-Hayes
Detroit, Mich., McGraw Plant



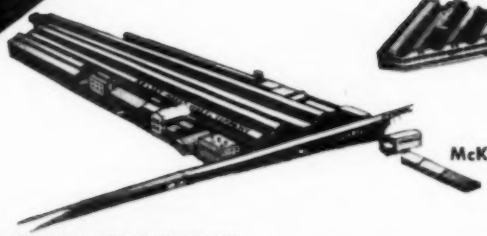
Kelsey-Hayes
Windsor, Ont., Canada Plant

Kelsey-Hayes
Detroit Mich., Military Plant



Kelsey-Hayes
Jackson, Mich. Plant

Kelsey-Hayes
Davenport, Iowa Plant



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For men who know firearms

2 new shotguns from Remington

These graceful new Remington shotguns are best appreciated by the man who really knows firearms. Both the pump action Model 870 "Wingmaster" and the autoloading "Sportsman-48" are streamlined beauties in polished walnut and fine steel.

But underneath all that, there's beauty in the simplicity of their functional design. For these new Remington shotguns have fewer working parts than ever before in Remington history . . . smooth, trouble-free action . . . lightness and natural feel that make them a delight to shoot—now and through the years.

Whether you prefer the autoloader or the pump action, you've a treat in store. See them at your Remington dealer's.

"If It's Remington—It's Right!"

Remington DUPONT

"Wingmaster" and "Sportsman" are Reg. U. S. Pat. Off. by Remington Arms Company, Inc., Bridgeport 2, Conn.

AMPEX MODEL 500 SIMPLIFIES TELEMETERING

Entire output of FM-FM receivers is recorded on tape without detectable error or loss of data.

AMPEX magnetic tape permanently records data in electrical form. Data reduction can then be carried out any time, any place and in any way. This eliminates the need for complex filter and discrimination systems at each ground station. This frequently lowers ground station cost and complexity to one-third that of alternative installations. Use of fewer mechanical and electronic components also decreases the chance of losing any critical data.

The AMPEX Model 500 was developed to achieve the extremely steady tape motion and high frequency response required in FM-FM telemetering. This performance also serves other data recording fields that have similarly high demands. The Model 500 has a frequency response up to 100 kc. to simultaneously record all RDB telemetering bands. Its extremely low tape flutter and wow account for an overall playback error less than 0.7%, (using subcarrier frequencies deviated ±7½%).

Features of the AMPEX Model 500

- *Records frequencies up to 100 kc. (including all RDB bands)*
- *Records the output of one to four receivers*
- *Overall playback error less than 0.7% on final data*
- *Less than 0.1% peak-to-peak flutter and wow*
- *Ruggedly constructed to meet military requirements*
- *16 minutes recording time at 60-inch tape speed*

Write for further information to Department L

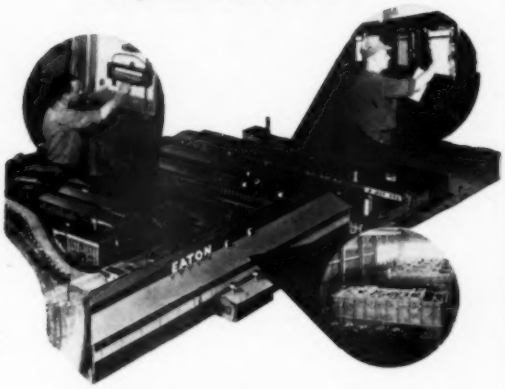
AMPEX

MAGNETIC RECORDERS

AMPEX ELECTRIC CORPORATION
934 CHARTER STREET • REDWOOD CITY, CALIF.

Special Steel

requirements?



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It always pays to "check with Fellows first". More than 50 years of experience in the diagnosis of the most intricate gear problems qualify Fellows engineers and craftsmen as experts.

Whenever the need arises, you are invited to draw on this valuable source of gear know-how. The answer to any gear problem, large or small, will be speeded by the application of Fellows precision manufacturing equipment.

Services like this have earned Fellows a reputation for leadership in the field of design and manufacture of complete equipment for cutting, finishing and testing gears.

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NEW

No. 955 Electronic Caliper

Now you can measure work-in-process in units from .0001" to .00001" without removing the work from the machine or fixture . . . or lifting the work from the bench. Apply the new No. 955 Brown & Sharpe Electronic Caliper to the work and take your readings on the No. 950 Electronic Amplifier.

Convenient 0" to 4" measuring range is provided by four interchangeable jaws . . . only one master is required for any particular setting. An aligning attachment is available which provides a positive three-point bearing when caliper is applied to long work pieces. Write for illustrated Catalog. Brown & Sharpe Mfg. Co., Providence 1, R. I., U.S.A.

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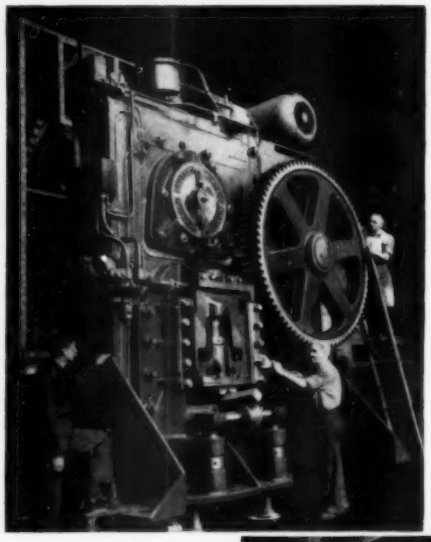

THIS NO. 15 "Buffalo" BILLET SHEAR

. . . and ready to cut clean and square, with no "smearing." Here is billet shearing on a high-production basis, far more economical and satisfactory than nicking and breaking. Above is one of three No. 15 Billet Shears just completed for a manufacturer of heavy axles. 14 feet high, these machines can cut 7" square billets and 20" x 2½" or 16" x 3" flat bars. 10 other sizes of "Buffalo" Billet Shears give you a complete capacity range. If you cut billets for forging, you'll do it cheaper and better with "Buffalo" Shears.

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BUFFALO FORGE COMPANY

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Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

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★ Interchangeability of tooling with minimum down time.

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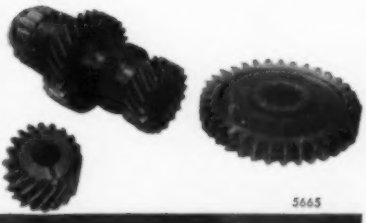

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Type I Medium	NC-710
Type I Firm	NC-711
MIL-T-6841	(DK-153 (RK-304S
Type II Soft	DC-167
Type II Medium	DC-100
Type II Firm	DC-113
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It will pay you to send us your blueprints for prompt quotations.

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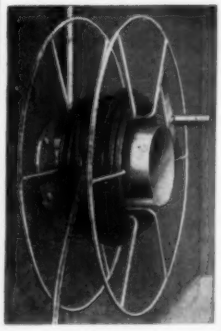

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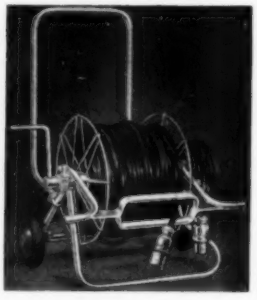
Eliminates "rassling" with long heavy cables. Reduces wear. Available with or without cable, wheels, handle. Has friction brake, lock—also standard Collector Ring up to 16 conductors. Reel—12" wide, 16" in diameter. Weight—21 pounds less cable and plugs.



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Designed for slow speed operation on special machinery and equipment requiring rotating electrical contract. Standard rings fit 1½" shaft. Furnished with driving collar equipped with set screws. Rings for any application can be designed, built to specs.

Any of the above reels can be modified. Or special reels for any industry or Armed Service can be built to specifications. Let us quote you on prices and delivery. Write:

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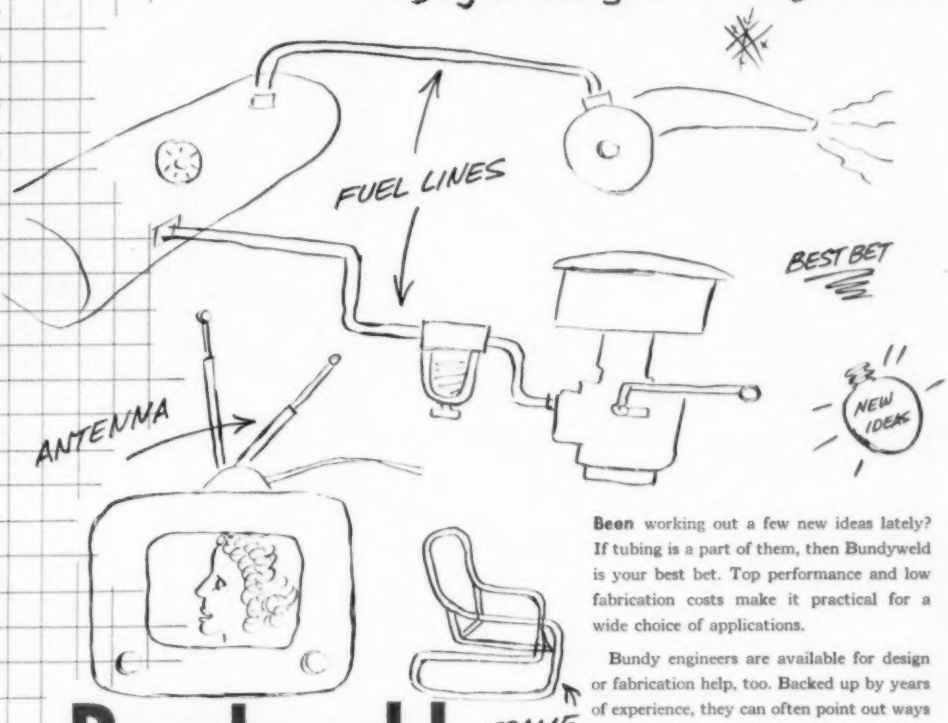
Bundyweld "Doodles"

to jog a designer's imagination



Been working out a few new ideas lately? If tubing is a part of them, then Bundyweld is your best bet. Top performance and low fabrication costs make it practical for a wide choice of applications.

Bundy engineers are available for design or fabrication help, too. Backed up by years of experience, they can often point out ways to save you time, material and money. Write for a catalog today.

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High thermal conductivity
High bursting strength
High endurance limit
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Lightweight
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Takes plastic coating
Scale-free
Bright and clean
No inside bead
Uniform O.D., I.D.

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Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness, and

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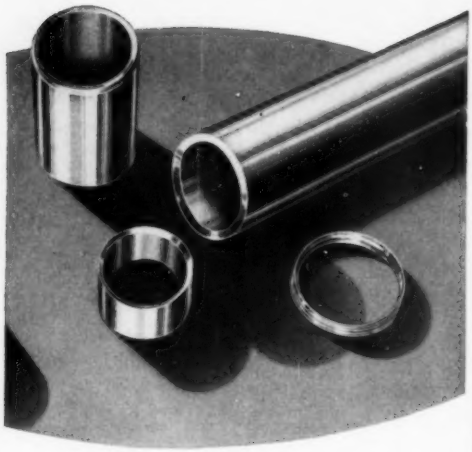

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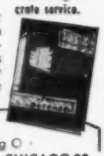

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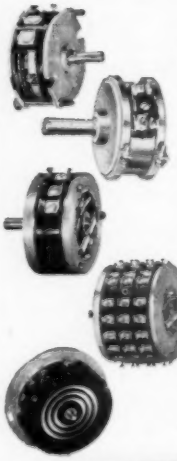

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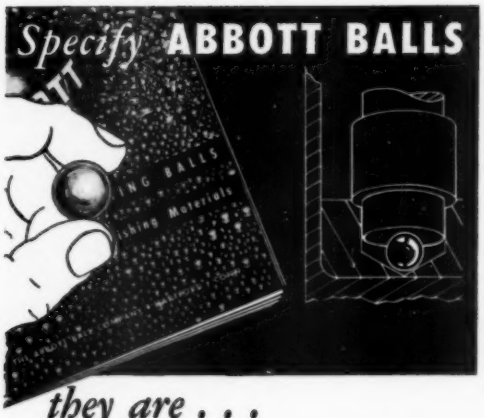

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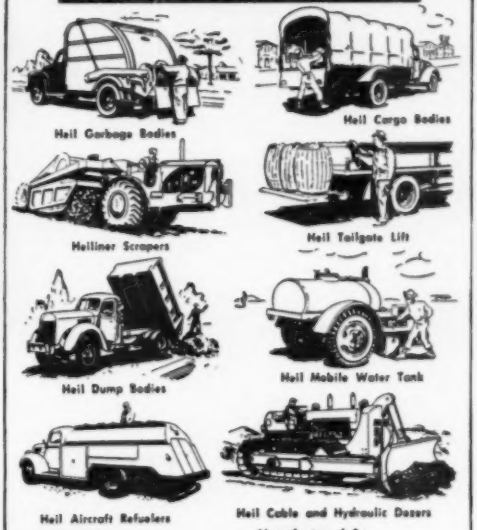

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Type 6	Parco Cleaners 100, 101, 110
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Type I (Wash-off)	Parco Cleaner 250
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MIL-C-5541 (Formerly AN-C-170)	Bonderite 700 (chemical film for aluminum and its alloys)
MIL-C-16232 (BuORD)	
Type I	Parco Lubrite 1 & 2
Type II	Parco Compound
PA-PD-191	
Grade I	Bonderite 32, 34, 100, 125, 140, 160, 170, 180
Grade II	
Type 2	Parco Cleaners 341, 350, 371
Type 4	Parco Cleaners 250, 260
Type 5	Parco Cleaners 210, 220
Type 6	Parco Cleaners 100, 101, 110
U.S.A. 72-53	Bonderite 32, 34, 100, 125, 140, 160, 170, 180
U.S.A. 57-0-2	
Type II	
Class A & A1	Parco Lubrite 1 & 2
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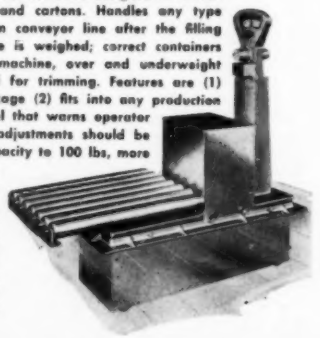

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The products shown here are a few taken at random from our voluminous file to give you an idea of the wide range of the fabricated tubular parts we have developed. By availing yourself of our specialized experience, you can save yourself many false moves and arrive at the solution to your particular problem quicker and more conveniently.

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NOVEMBER-DECEMBER, 1952

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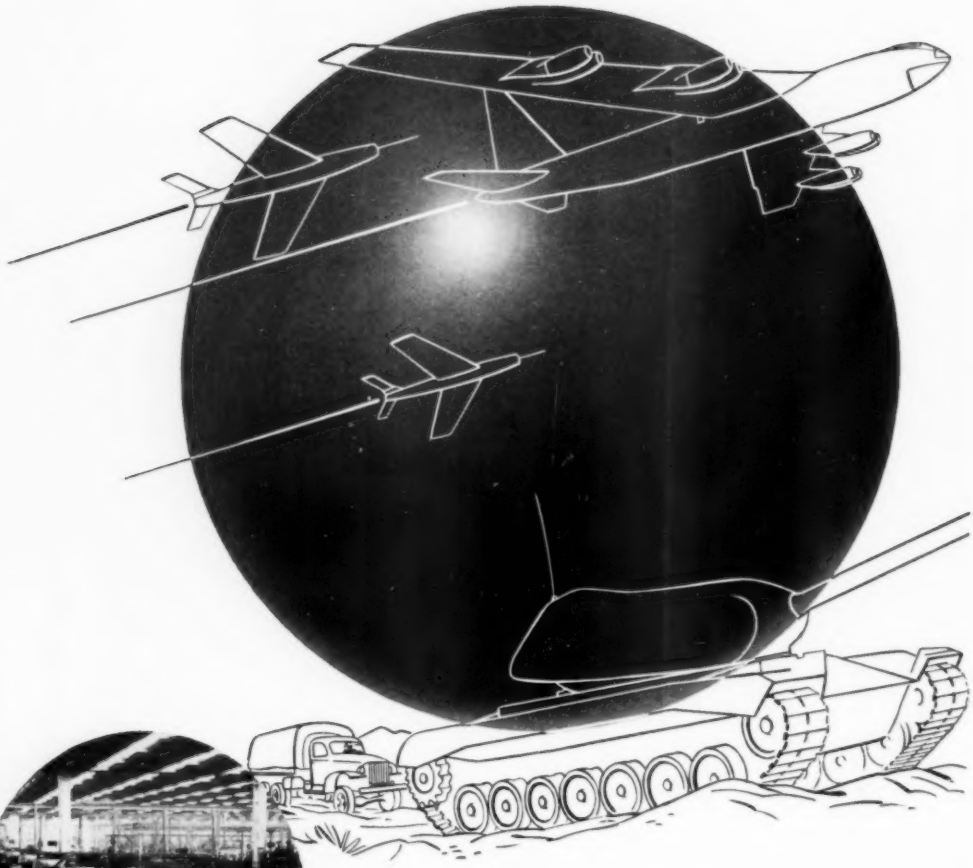

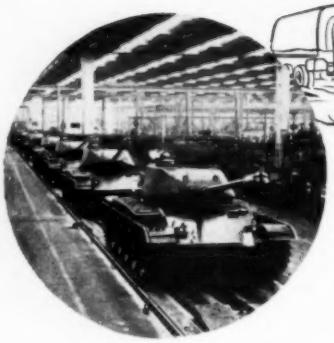

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ARMAMENT TECHNOLOGY

This section of ORDNANCE contains articles of a detailed and technical nature on ordnance research, development, manufacture, field use, and related subjects.

Shearing Shell Billets

Modern Method Improves Forging Production Rate

William C. Tucker

Chief Engineer, Machine Tool Division, Buffalo Forge Company, Buffalo, N. Y.

WITH numerous contracts for the forging of shell already in process and many new ones still being placed, there exist many questions among the manufacturing contractors concerning the best and most acceptable method of parting shell billets. Because of the divergent opinions encountered on the subject, a survey of outstanding facts may, and should, prove helpful to all in the shell-forging field.

The object of this presentation is to state these facts as simply and briefly as possible, instead of embarking on a long technical discussion.

Method Not Mandatory

Interviews with U. S. Army and Navy ordnance personnel, as well as close inspection of existing specifications on the forging of steel shell, clearly indicate that the manufacturer is not told he *must* use any particular method of parting shell-stock billets in preference to any other method. The inspection requirements for the various methods, however, are clearly stated.

A frequent misunderstanding occurs among manufacturers when the inspection requirements are read. The specifications state that material divided by the nick-and-break method must have the fracture test on *each blank*, but only on the end that will be used as the base of the shell.

When a method other than nick and break is used, such as shearing, the macrostructure test shall be made on each end of each *bar*. This does not mean *each blank*, but each maximum-length bar of twenty-five feet.

The fracture test has its value and is widely used in revealing quality characteristics of steel. Visual inspection of fractures should always be conducted by skilled inspectors, properly trained to look for flaws. Ordnance specifications are quite clear and comprehensive on the subject of inspection, both in regard to mill inspection and to forging-plant inspection. Careless visual inspection of fractured ends can lead to serious consequences.

The method of gas-torch nicking and breaking of billets has many adherents and supporters, but it must not be overlooked that it also has attendant disadvantages. High operational costs must be considered. Repetitive handling of material is hard to avoid. The cost of the gas used in nicking is a large item.

If hydraulic presses are used for breaking instead of mechanical presses, maintenance costs will be greater. Furthermore, fractures are frequently irregular and hard to control, leading to subsequent forging difficulties.

Opposing Forces

When metal is sheared, as in the case of a round or square billet, the shear knives represent two opposing forces that build up pressure at right angles to the longitudinal axis of the billet. In the nick-and-break method, the nick is most usually made with a gas torch after which pressure is applied to the end of the billet blank at right angles to the longitudinal axis.

However, because of a cantilever advantage, the actual pressure is multiplied and transmits the stress to the

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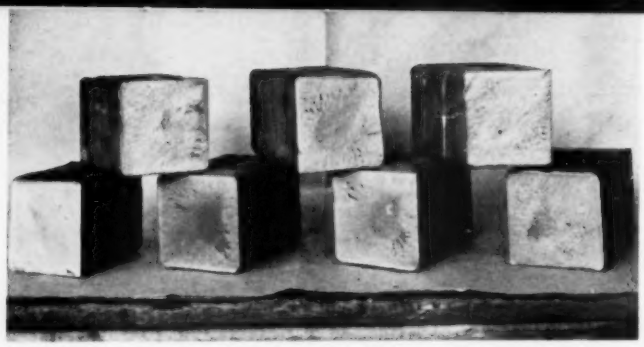
Powder Metallurgy 525
Capt. John D. Dale



The 4-inch steel billets, shown above, were sheared continuously at the rate of twelve pieces per minute yet retained uniformity and squareness.

area immediately under the nick as a tensile stress instead of a shearing stress. The resulting fracture is often rough and irregular when compared with a shearing fracture.

Nicking billets by other methods than the use of a gas-torch cut have been tried with varying degrees of success and failure. It has been found that a sharp "V" cut can successfully start a fracture, but there is a limitation on the size of billet where good breaking will result. Good breaks have been obtained on billets up to and including four inches square, but over that size the billet has a tendency to bend under pressure rather than fracture.

"Shearing" does not mean a knife cut through the full cross section of a billet, successively severing each fiber with its cutting edge. Such a conception has led to the erroneous belief that the billet surfaces are smeared by the knife, preventing observation of defects.

When properly analyzed, shearing is actually a combined nick-and-break operation in rapid sequence, with no waste of material. The shear-knife penetration on shell steels is seldom more than 3/16-inch, at which point fracture occurs, as at this instant the built-up pressure of the shear knives exceeds the yield point of the material being sheared.

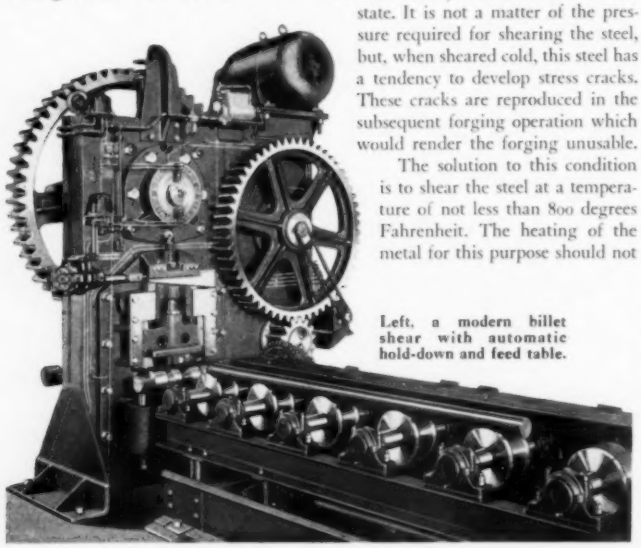
Fracture Localized

The proximity of the two shear-knife edges in the vertical shear plane localizes the fracture with considerable accuracy between the indentations of the knives. In this manner the best possible control is exercised over the squareness and smoothness of the fractured ends.

It is a well-recognized fact that billets over and above four inches square with a carbon content higher than .50 are not readily shearable in the cold state. It is not a matter of the pressure required for shearing the steel, but, when sheared cold, this steel has a tendency to develop stress cracks. These cracks are reproduced in the subsequent forging operation which would render the forging unusable.

The solution to this condition is to shear the steel at a temperature of not less than 800 degrees Fahrenheit. The heating of the metal for this purpose should not prove detrimental to good forging practice as the billets should pass directly to the furnace for forging heat. In this way a portion of the original heat is conserved.

On the other hand, if the steel is heated as suggested above, it is not necessary to forge immediately after shearing. Steel sheared at 800 degrees Fahrenheit may be stored indefinitely without danger of stress cracking and subsequent rejection.



Left, a modern billet shear with automatic hold-down and feed table.

Inspection Enhanced

Exhaustive tests have proved that shearing either round or square steel billets does not smear or obliterate visible indications of porosity or pipe on the sheared surface. As a matter of fact, shearing enhances visual inspection and detection of such defects. It is possible to see these defects on sheared ends of billets far more easily than on broken ends.

With the highly developed shearing aids that are available on billet shears for forge-shop use, the quality of the cut is definitely assured. Modern billet shears are equipped with automatic hold-downs that clamp the billet immovably during the shearing operation and quickly release for the next billet movement. Automatic power-feed tables position each blank against the positive stock gage. Equipment of this nature permits continuous automatic shearing to accurate dimensions.

Uniform Dimensions

Records in many of the automotive plants indicate that multiple blanks are being sheared within variable limits on 4-inch-square billets not exceeding 2 ounces in weight. This is a very important advantage that insures dimensional uniformity of forging stock as compared with the nick-and-break method. Uniformity of dimensions is conceded to be highly successful in improving subsequent shell-forming processes.

When planning to shear shell-stock billets, the forging contractor can expect to gain the highest rate of production of forging blanks with minimum handling costs. This is true in both cold and hot shearing.

Highly satisfactory records have been established by many manufacturers shearing shell stock now and during the past decade. This statement is made with recognition of full conformity to Ordnance specifications relating to tests and inspection.

A New Tank Design

Advantages Claimed for a Vehicle Hull of Spherical Shape

by

Lieut. Col. H. de J. Keays

Colonel Keays is Chief Inspector, R.E.M.E. Inspectorate, British Middle East Land Forces. In World War II he was a British liaison officer with the Office, Chief of Ordnance, Detroit.

SINCE the invention of the tank in World War I and the production of the first model with rotating turret and unified driving control, which emerged soon after that war, there have been few important changes in basic design although there have been many improvements in components.

It is the conviction of the writer that the last war saw the end of a period in tank development; a period during which the development of tanks in their present form has been carried to the limit. In any future war, if we are to secure a substantial advantage over our enemies, we must abandon old methods of design and seek a new approach to the problem.

Boldness Needed

Boldness and originality of conception are needed now—not a tedious pursuit of perfection in detail, vital though this undoubtedly is. The whole question of the design of armored vehicles must be studied anew.

It is interesting to examine the tank types of America, Britain, and, indeed, of all nations. When we do so we find a broad similarity in their main dimensions and in the disposition of essential parts. Sometimes there is emphasis on one feature, sometimes on another, but always accompanied by an equivalent sacrifice elsewhere.

Types of Tanks

When the emphasis is on armor we have the so-called "infantry tank"; when on firepower we have, in British terminology, the "gun tank."

Fig. 1. Tank model shows spheroid design of the fighting compartment.

Tremendous effort has been expended on the problem of up-armoring and up-gunning within known reliable weight limits, but the sacrifice of some qualities to obtain others practically as important has been very great in every case.

Armor vs. Firepower

If the fighting space provided with the heavier weapons is reasonably good, the possible degree of armor protection is low. Increases in armor that have been made, usually over a limited frontal area, result in reduction of firepower and secure little tactical advantage.

Clearly, tanks in their present form offer little scope for further improvement. The development of a heavily armored tank with high firepower, whatever its tactical rôle may be, has become a basic design problem that cannot be solved on conventional lines by the rearrangement and modification of existing types. An entirely new design conception is needed.

A tank possesses three basic qualities: Firepower, mobility, and armor protection. Tactical employment will determine which of these qualities is the most important; emphasis on any one means degradation of the other two, and the final design must always be a compromise.

Broadly speaking, tanks fall into three main tactical classes covering reconnaissance, infantry support, and exploitation of a break-through. In each of these classes the nature of the design compromise is different. For reconnaissance, mobility is the prime requirement, with firepower second and armor last. For support, firepower and armor come first and, in their interest, speed must be sacrificed. The tank which is to be used to enlarge an entry to a break-through and to exploit it must combine the essential qualities in the following order of importance—firepower, mobility, and protection.[1]

Factors Involved

The basic qualities of firepower, mobility, and armor protection depend on certain factors which should be borne in mind. Primarily, firepower depends on the armament, on its caliber, the type of projectile, and its velocity. Of equal importance, however, are the rate and accuracy of fire, and these are determined by the means for observation and by fire-control devices generally.

Also influential are the size and arrangement of ammunition, the design of the gun—whether automatic, semi-automatic, or manual—and the kind of loading aids. And, finally, of great importance are the crew disposition and the space available in the turret and fighting compartment.

Mobility is determined by speed, maneuverability, cross-country performance, and range. High speed demands good acceleration which implies a high power-weight ratio, and this, in turn, demands a well-designed flexible transmission.

Maneuverability demands an efficient steering mechanism with simple and effective control. Cross-country performance depends on low track pressures, good obstacle-crossing and climbing ability, and efficient wading arrangements.

Range requires low fuel consumption, a well-designed transmission permitting efficient engine operation, and a large fuel capacity.

Armor Protection

Armor protection is primarily a function of armor thickness, but the method of application, design of gun mount, and essential apertures, and the ballistic shape (the obliquity presented to projectiles), are enormously important.

Certain external factors, additional to those enumerated above, can influence design, but they are to some extent outside the designer's control and must be accepted. Thus over-all dimensions are limited by considerations of transport, width, strength of bridges, etc. Obstacle-crossing requirements determine shape fore and aft; general ground conditions limit unit track pressures, and so on.

Other influences are more subtle and not so readily appreciated. In recent years the tank has been studied as a mechanism rather than as a weapon of war. The mechanics of tank steering, propulsion, and soil resistance were not properly understood, and even now there is much basic research still to be done.

At the beginning of the last war, tank design was a backward art from the engineering point of view; it is not surprising that attention was devoted far more to the mechanism than to the fighting qualities. In consequence the balance of designs was not good.

In 1940 the best British tank weapon was the 2-pounder, and, in the case of early models of the Churchill tank, a vehicle of nearly 40 tons was needed to carry it into battle. Even with that weight the armor was not great.

Gun Least Important

From the designer's point of view at that time, the gun was the least important element; its installation seemed to present no serious difficulty, and the problems of the power plant, suspension, etc., seemed far more complex.

As design succeeded design, so more and more ingenuity was expended on the detail of components. The modern tank shows this ingenuity carried almost to the limit, and we have highly efficient power drives, suspensions, fire-control devices, and so on.

The gun has received a more generous share of the designer's attention, but, even so, the basic conception has not progressed far. Fundamentally it is always the same kind of layout, with a highly conventional fighting compartment and crew disposition.

Thus in general, the tendency of designers over the last decade has been to concentrate on details; to study the problem piecemeal rather than to try and achieve a comprehensive and original idea of a tank as a complete entity—as a weapon of war with all its qualities in symmetrical balance.

In days gone by, when tanks were just simple, heavy, track-laying vehicles with some thin armor and light guns, the designer's problem was easier. It was sensible for him to save weight where he could as, for example, by the use of light radial aircraft engines.

Situation Changed

As the demand increased for big guns and thick armor the situation became very different—the *shape* and *arrangement* of the internal components now dominated all other considerations. The biggest single weight item was the weight of the armored envelope.

Since the earliest days of the tank until the end of the last war the weight of the armor has steadily increased from a relatively unimportant figure until it is now by far the greatest proportion of the total weight.

This increase is very significant, and

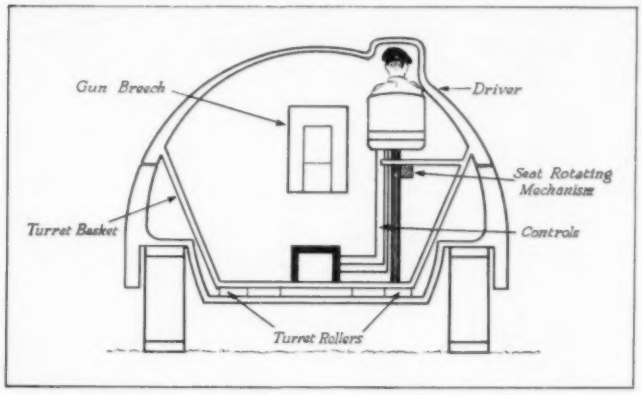


Fig. 2. Driver's seat revolves so that he always faces forward as turret turns.

a study of the methods of applying armor provides a good approach to the whole design problem.

Advantage of the Sphere

Now a sphere will enclose a given volume with approximately twenty per cent less surface area than a cube, and the advantage of the sphere over an elongated rectangular box amounts to some thirty to thirty-five per cent saving in area. The saving which the sphere has over a rough rectangular structure such as a tank hull is, at the very least, fifty to sixty per cent!

It is thus clear that in order to make the weight of the armored envelope of a tank least for a given enclosed space and armor thickness, or to obtain the maximum protection for a given enclosed space and total weight, the vehicle should be spherical.

Let us now try to conceive an idealized vehicle on this basic principle in which the upper hemisphere carries the gun and rotates on the lower hemisphere carrying the tracks and propelling mechanism.

Practical Considerations

Practical considerations at once begin to operate: the railway loading gauge dictates about 125 inches maximum width so that, almost inevitably, the power plant and drive must go in an armored enclosure between the tracks to the rear.

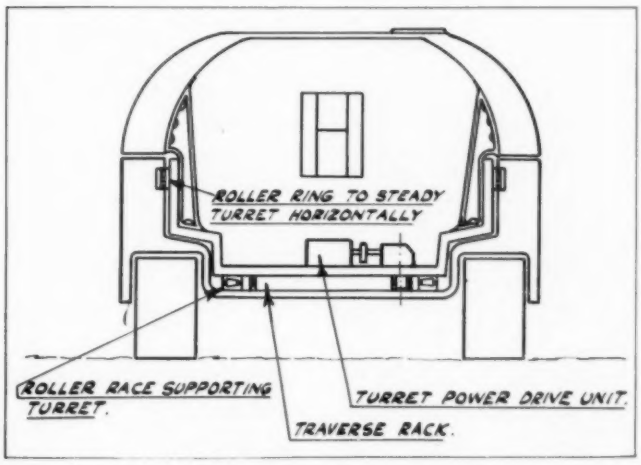


Fig. 3. Diagram shows turret support rollers and power drive unit.

Plenty of Room

The remaining sphere for gun mount and crew can be fitted comfortably within the 125-inch limit and will allow room for a large gun breech, a good ammunition supply, and at least four men. If we now make one of these men a driver, the whole of the front driving compartment on the ordinary tank can be removed. (On the conventional tank the front driving compartment costs many tons in weight.)

Further practical considerations will modify the sphere until it approximates the shape of an oblate spheroid. The illustrations on page 515 show photographs of a small wooden model which indicate the kind of shape which might be developed.

Briefly, then, it is suggested that tank design should start with gun, crew, stowage, and controls, etc. When the optimum arrangement has been found for these, the armored envelope should be wrapped around it as nearly as possible in the shape of a sphere.

It can be argued that the finished design will not greatly resemble a spherical form. This is agreed. The object of the writer in the present analysis, however, is to seek a new approach to the design problem—to define a criterion, and the spherical principle establishes this criterion.

One logical conclusion which now emerges is that the conventional driving position can no longer be retained; the crew members must be assembled as closely as possible together within the armor as practical considerations of fighting efficiency will permit.

Remember the Principle

Although it may be necessary to depart a great deal from the spherical form in designing the armor envelope, the designer should keep the principle firmly in mind as it is a true guide to the best possible shape.

Quite different considerations lead us to the same conclusion. The facility with which a tracked vehicle can be steered depends to a great extent upon the ratio of the length of track on the ground to the distance between the track centers. The greater this ratio, the greater is the steering effort required

in any given set of circumstances.

The steering problem becomes difficult with ratios in excess of 1.7 to 1; vehicles have been built where the ratio has been as high as 2.5 to 1 but "steerability" has then been very poor in consequence.

Low Steering Ratio

From this point of view, then, we should aim at a low steering ratio; the tank should be short in comparison with its width. This is another powerful argument for dispensing with the front driving position and for following the spherical principle and putting the driver in the turret.

Tracks and suspensions, and those internal mechanisms which support and drive the turret and control the gun mount, are major sources of weakness in any tank. Battle experience has proved they must be kept as low in silhouette as possible in order to be inconspicuous and safe from attack.

For example, the shock from a heavy antitank projectile, even though the armor is not penetrated, can render an elevation gear useless. Yet elevation gears are still installed high up on the turret walls where the danger from shock is at its greatest.

In the model illustrated, the tracks are shown depressed below the horizontal plane occupied by the gun breech. In this way a very low silhouette is possible and the full width of the vehicle (125 inches, less armor thickness) is available as fighting space around the gun breech, combined with the greatest safety for tracks and suspension.

An incidental but important advantage of the enlarged fighting space obtained in this way is that it permits the introduction of an efficient automatic or semiautomatic gun loading mechanism. Mechanization of loading is vital, for, particularly with the large guns now being mounted, the manhandling of heavy ammunition is no longer acceptable.

Larger Weapons Feasible

If the 125-inch railway loading gauge is disregarded, larger fighting compartments with still bigger weapons are feasible.

Turret support rings carried on the hull roof, as in present practice, have several serious drawbacks. They cause a severe constriction of space in the plane of the gun breech, and this is made worse by the presence of traverse rack and traverse drive unit. They constitute a serious weakness right in the center of the tank.

Considerable reënforcement is needed in the fighting compartment to carry the weight of the turret, and the manufacture of large race rings and traverse racks is a tiresome production task.

To obviate these bad features, turrets should be supported centrally from a position between the floors of the fighting compartment and hull; here also the traverse mechanism can be located safe from attack. The main support for the turret can be a relatively small roller track or even a central ball or pivot.

At the top of the hull there would be a simple internal ring on which rollers would absorb horizontal thrust to steady the turret and withstand shocks from the impact of projectiles. The elements of this proposal are illustrated in Figure 3.

Electric Drives

The tank of the future must be equipped with an infinitely variable transmission demanding little or no skill from the driver. To this end hydraulic and electric drives were developed during the war, and the exceptional advantages of electric systems of propulsion were clearly demonstrated in experimental models built on both sides of the Atlantic.

As regards mobility, there is first of all the advantage of the great flexibility of electric power drives. High speed in reverse which was found to be an essential tactical requirement in the last war is very easily provided; a tank could, in fact, be designed which would have an equally effective performance when going either backward or forward. This quality is difficult to achieve mechanically, although good results have been obtained with automatic hydraulic power drives.

As regards armor protection, electric power drives have valuable qualities which help in the search for optimum grouping. For example, we might locate engine and generator at the front with traction motors at the rear.

With the layout of the power plant described above, the center of gravity automatically assumes a more satisfactory location, and the designer has a freer hand in the distribution of armor.

Electricity offers several incidental advantages. The driver's task is simplified and he is able to concentrate far more on the terrain; he is relieved of the task of gear shifting; and driving fatigue in heavy cross-country going is much reduced—all points of great operational importance.

Duties Combined

In view of the great advantages in driving control offered by electricity, the combination of the duties of driver and commander, at least on the heavier tanks and particularly on gun motor carriages, is thought to be well worth consideration. If this principle were accepted, the scope for design improvements in the layout and equipping of fighting compartments would be tremendous.

As we mount more and more powerful guns, the proportions of the turret become quite alarming, and it is very necessary to seek an alternative. Many have been suggested, such as the limited-traverse turret and the gimbal-mounted gun.

For large machines with very powerful guns and thick armor, a simple solution is to lay the gun by rotating the entire tank. Turrets and other systems of separate rotation can then be dispensed with altogether.

It is agreed that there are many criticisms which might be made of this proposal, not the least being the difficulty of operation on rough or hilly ground. The idea, however, is believed to offer a useful line of development for some special types of machine.

Study Necessary

It is contended that the advantages of firepower and armor protection are likely to be so enormous as to make a proper design study on these lines very necessary. It is a type of design which allows the closest possible approach to the spherical principle.

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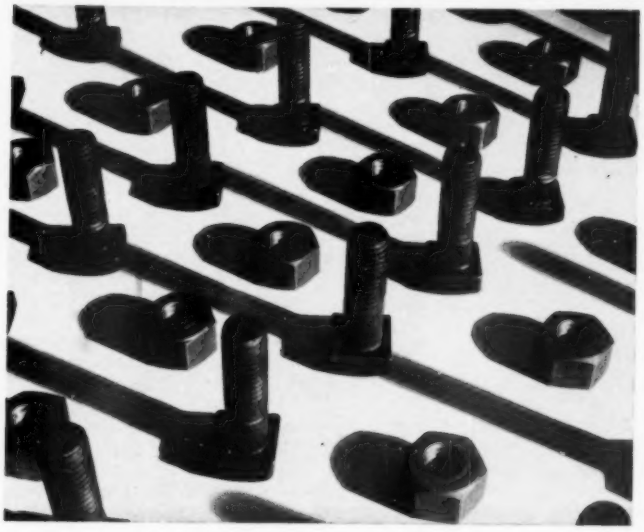


Screw-Thread Standards

Technical Problems in Adopting Unified Inch and Metric Systems

By I. H. Fullmer

BOMB sights, gun carriages, radar reflectors, and all the other complex equipment of modern warfare are held together by literally millions of threaded fasteners—bolts, nuts, and screws. One type of airplane, for example, uses 122,000 screws.

Economical production of such items by assembly-line methods requires not only a steady stream of components but also that the components, including large numbers of fasteners, be interchangeable so that they can be fitted together without selection, subsequent machining, or hand fitting of any kind.

Interchangeability

Interchangeability of threaded parts becomes even more critical when partial assembly or replacement of components must be carried out in a combat area.

During the First World War the experience of the allied American and European armed forces revealed that the lack of interchangeability of American and European screw threads was a serious problem. In World War II, the high degree of mechanization of all military forces made the problem much more serious.

American industry was required to supply the British with a large volume of war equipment threaded to the British specification. This not only led to considerable delay but was economically disadvantageous. At the same time, American military forces based in England and using equipment with American threads found difficulties in making necessary replacements.

Since the war, significant progress has been made in American-British-Canadian screw-thread standardization, and difficulties of this kind are considerably less likely to occur among the inch-using nations. However, many problems remain to be solved before world-wide standardization of screw threads can be achieved among both inch-using and metric-system countries.

A screw thread is one of the more complex regular geometric forms. Many variables thus enter into the design of a threaded fastener. These numerous design factors, together with the far-reaching economic considerations involved in changing from one type of thread to another, make the problem of standardization a difficult one.

Five Characteristics

The five principal characteristics of screw threads—and thus of any standard thread system—are (1) thread profile (angle and form of thread), (2) pitch or threads per inch, (3) size or diameter (which in combinations with pitch defines the thread series), (4) allowances providing for minimum clearances or maximum interferences between mating threads, and (5) manufacturing tolerances which determine the permissible variations in the dimensions of thread elements.

The thread profile is really the basis of the thread system, and standardization of a thread system is achieved in large measure when a standard profile and a standard series of diameter-pitch combinations have been agreed upon.

Universal standardization of screw threads would be much simpler if it were possible to decide on a single thread system applicable to the entire range of required sizes and all types of products. However, different thread profiles are required for different applications. Also, a given class of products, such as bolts, may require, for technical reasons, two or more series of diameter-pitch combinations in a given size range.

Adopt Several Systems

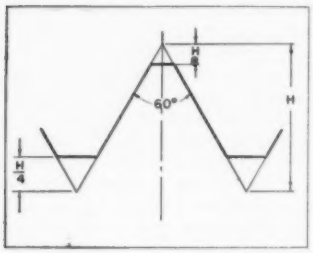
Thus, the only feasible method of universally standardizing screw threads would seem to be the adoption of several standard thread systems, with the understanding that only one is to be used for a particular class of products in a given size range.

To date, practical considerations, the

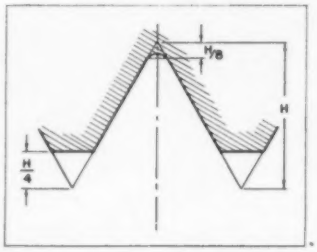
As a physicist in the gage section of the National Bureau of Standards, Mr. Fullmer has been actively concerned with standardization of screw threads for the past twenty years. He is now secretary of the Interdepartmental Screw Thread Committee.

most important of which is the existence of both metric and English measuring systems in the different countries of the world, have prevented universal standardization on this basis.

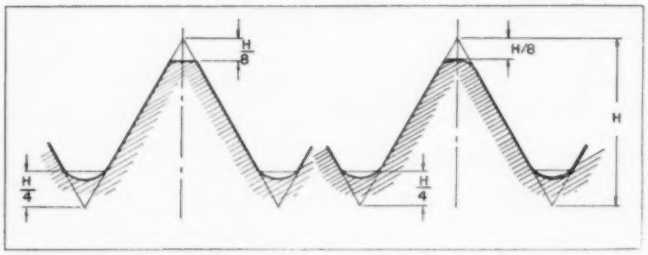
An outstanding recent achievement in the standardization of screw threads was the agreement by the technical committee on screw threads of the International Organization for Standardization, meeting in Paris in 1949, on basic profile and "maximum material" (or limiting) forms for external and internal threads for bolts, nuts, and screws.



ISO basic profile for triangular threads.



Recommended maximum internal form.



Recommended maximum material forms for external threads.

The ISO profile, approved by a majority of the twenty-one countries represented, is in all essentials the same as that of the Unified thread system adopted by representatives of Canada, the United Kingdom, and the United States, meeting at the National Bureau of Standards in November 1948. (See illustrations on this page.) Thus, there already exists the first essential of a universal standard screw-thread system for bolts, nuts, and screws.

Unified Profile

The Unified profile provides a 60-degree angle and a rounded root for screw threads. The crest of the external thread may be flat, as preferred in American practice, or rounded, as preferred by the British, since interchangeability is not affected by this detail.

The Unified form is now generally applicable to all sizes of bolts, nuts, and screws ¼-inch (6 mm.) in diameter and larger made in this country. Its application to sizes down to one mm. (0.04-inch) has been agreed upon by the ISO committee, and further extension of the range is probable. In the Unified system, the form agreed upon is universally used in the United States and Canada for all engineering applications in sizes down to 0.06-inch, and in the United Kingdom for certain engineering applications in five sizes down to 0.112-inch.

Inroads Made

In the few years since its adoption the Unified profile has made appreciable inroads on other profiles, such as the American Standard and the British Standard Whitworth, for bolts, nuts, and screws in sizes ¼-inch or larger. However, in sizes smaller than ¼-inch, the ISO basic profile or Unified profile is not likely in the near future to displace completely the other profiles used on instrument and machine screws, such as the British Association form.

Nevertheless, the possibilities are good for its adoption for several sizes of instrument screws approximately one mm. (0.04-inch) in diameter. For sizes less than one mm., a thread angle of 50 degrees rather than 60 degrees is now widely used by watch manufacturers.

Accord Reached

The ISO committee has not yet given consideration to the adoption of thread profiles for applications other than bolts, nuts, and screws. However, among the inch-using countries, accord has now been reached on the 29-degree Acme form for translating threads such as lathe lead screws. Partial agreement on a profile for buttress threads, which are designed to bear extreme axial loads, also has been attained.

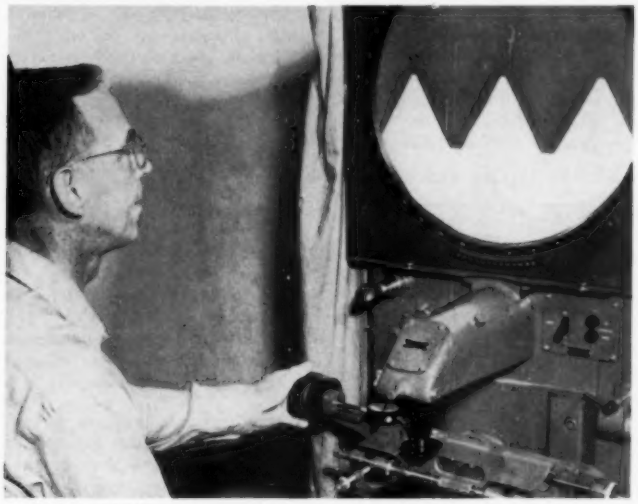
Agreement has been reached on flank angles of 7 degrees and 45 degrees, but the relatively shallow thread depth (0.4 times the pitch) proposed by the British is not considered by the Americans to provide sufficient bearing area for heavy loads.

Pipe threads are made to two standard profiles, both of which are extensively used throughout the world: the so-called Briggs, American Standard, or American Petroleum Institute line pipe profile and the British Standard Whitworth pipe thread (see p. 522). Unification of these threads has been the subject of much discussion, but seemingly insurmountable economic problems have thus far prevented any progress toward unification.

Two Series

In the Unified thread system there are two principal series of thread sizes for bolts, nuts, and screws. These are the Unified coarse and fine thread series. Numerous other selected combinations of special diameter and pitch are available in the Unified system for other applications such as constructional threads. A large proportion of these selected combinations are included in the American National extra-fine, 8-thread, 12-thread, and 16-thread series.

Use of the Unified thread series is progressively increasing throughout the inch-using countries. In the United States, well over 60 per cent of commercial bolts, nuts, and screws are made to the Unified specifications, and the Unified system is authorized for use by the armed services.



Optical projection comparator being used to measure flank angles of a plug gage.

The transition from the American National to the Unified system is being greatly aided by the temporary use of inspection or acceptance gages whose limits embrace the limits of corresponding class numbers of both systems.

In countries using the metric system of units, where engineering designs are based on metric modules, fasteners in standard inch sizes are often difficult to apply. To remedy this situation, a compromise system of thread series has been suggested in which dimensions would be tabulated in both inches and millimeters, but actual sizes would favor metric modules in some cases and inch modules in others.

Inconvenience

The chief disadvantage of such a system from the viewpoint of the inch-using countries is the inconvenience it causes in cutting threads to a given pitch. Because gears can have only integral numbers of teeth, it is obviously more convenient in producing a prototype thread to choose pitches in which the number of threads per inch can be expressed as an integer or as a simple mixed number like $7\frac{1}{2}$ or $1\frac{1}{3}$.

However, if the pitch is expressed by an integer or simple mixed number in one system, in the other system it can be expressed adequately only by recording several decimal places. Nevertheless, by the choice of suitable compound gearing, "inch" threads can be cut on a lathe having a metric lead screw, and metric threads can be cut on an "inch" lathe.

Thus it appears that there is no really difficult technical obstacle to a single international thread system for both inch-using and metric-system countries provided the necessary specifications of thread profile and pitch can be agreed upon.

The ISO committee is now working to develop a unified system of metric threads which will provide the minimum variety of sizes necessary to meet technical requirements. Success in this task will bring advantages to both inch-using and metric-system countries.

Metric Standards

In the United States, where metric threads are manufactured for export machinery, the use of metric standards corresponding closely to the present Unified thread system will simplify shop drawings and instructions and make them more readily understood by the workers.

For translating threads it is not especially important that there be a unified thread series. However, procurement is simplified when a series of diameter-pitch combinations is available. Such a series has been published in the United States as the Acme thread series, and this series is being considered for unification by the inch-using countries.

As has been mentioned, there are still two standard forms of pipe threads —the American Standard and the British Standard Whitworth—and each has its corresponding thread series.

Measuring pitch diameter of a taper-thread plug gage with a horizontal comparator.

Clearances between the crests and roots of threads are most conveniently provided by specifying the maximum material thread forms, as has been done for the ISO basic profile, and then tabulating for each thread series the corresponding major and minor diameters (the diameters at the crests and roots). Various gradations of such clearances are not necessary for bolt and nut threads but have been developed for other types of thread profiles.

The Acme Thread

For example, in the so-called "centralizing Acme thread," which is used for power transmission, the minimum clearance at the major diameter is less than for the "general-purpose" thread and also less than the allowance on pitch diameter (diameter across thread flanks). This design assures contact at the crest of the thread instead of on the flank when the rotating screw is supported in the thread instead of in bearings at the ends.

The recently developed Dryseal pipe thread is another specialized thread in which crest and root truncations are held within narrow limits in order to provide contact over the entire thread profile when assembled, thus preventing leakage of fluids through the threads.

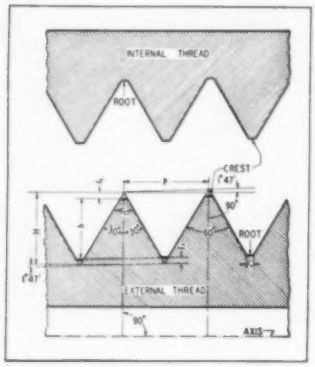
Minimum Clearances

Minimum clearances (or maximum interferences) on pitch diameter are designated as allowances and usually constitute an important element in the design of a thread assembly. The fact that the allowance may be zero in many cases often causes the need for an allowance in other cases to be overlooked. An outstanding example of a carefully designed positive allowance is that for class 2A threads in the Unified system. This class is intended to provide for the bulk of production of bolts and screws, and the majority of such products now produced in the U. S. and Canada is made to this class.

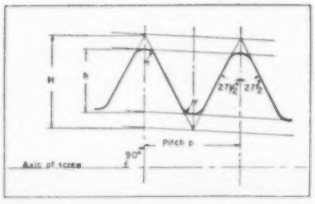
Prevent Galling

The principal purpose of the class 2A allowance is to prevent or minimize galling or seizure of parts of like or similar composition in assembly or use. It is also available for plating of threads. On munitions which may be assembled in the field, an allowance is frequently provided to permit ready assembly even when the threads are slightly bruised or dirty.

The variables which enter into the determination of tolerances for screw threads are so numerous and difficult to define quantitatively that the approach to the development of standard



The American Standard line pipe profile.



British Standard Whitworth pipe thread. Taper, one inch in 16 on diameter. $H = 0.960237 \times p$; $h = 0.640327 \times p$; $r = 0.137278 \times p$.

tolerances has been largely empirical. International standard tolerances are now being formulated by the ISO on the basis of experience over the past thirty years with the national standards used by the Americans, British, French, and Germans.

The Unified system of bolt and nut threads provides standard tolerances for major diameter of external thread, pitch diameter of both external and internal threads, and minor diameter of internal threads. In this system, major diameter tolerances are based on a simple function of the pitch.

Diameter Tolerances

Pitch diameter tolerances are cumulative; that is, they include errors both of pitch and thread angle. They are composed of three increments which are functions, respectively, of diameter, length of engagement, and pitch. The increment based on pitch comprises over fifty per cent of the total and provides for variations in angle and thread form such as occur with wear of the production tools.

The necessity for basing these tolerances on the sum of three such increments is recognized in practically all thread systems, but emphasis has usually been placed on the diameter or length of engagement. However, the totals of the three increments for the more common diameter-pitch combinations are in reasonably good agreement among the different systems.

Internal Threads

The tolerance on the minor diameter of internal threads has been the subject of much study in the United States. The principal factors which determine these tolerances are tapping difficulties, particularly tap breakage in the small sizes, and depth of engagement.

From the above discussion it should be evident that screw-thread standardization involves complex problems, both technologic and economic. Yet there now is greater need for international standardization of screw threads than ever before.

In the past, international trade in mechanisms of all kinds has been seriously handicapped by a lack of interchangeability of threaded parts. Today machines and mechanized units, particularly those used for transportation, are not only being extensively exported and imported by the nations of the world but are moving rather freely from one country to another.

A Common Standard

Obviously, the servicing and maintenance of this equipment would be greatly facilitated if all threaded parts having a particular functional use were made to conform to a common standard. Perhaps the practical difficulties involved will make a single standard for bolts, nuts, and screws impossible of attainment.

However, agreement on two alternative systems, the present Unified inch system and a unified metric system, seems well within the realm of possibility. If this can be accomplished, the number of thread systems for which parts must be provided will be greatly reduced.

Requirements of the Staff Officer

The Proper Philosophy Is as Important Here as in Combat

Lieut. E. C. Schroder, Jr.

MANY official documents deal with the subject of staff work as it pertains to planning and coördinating personnel, intelligence, operations, or supply activities. These publications reflect accurately and completely the definition and functions of the staff and the standard by which to judge the efficiency of its activities. In essence, the appropriate manuals state that:

The Officer's Duties

1. A staff officer must have had prior experience as a subordinate commander in the type of unit to which he is assigned or should have undergone an adequate period of orientation before beginning his staff duties.

2. A staff officer should be an active well-informed assistant to his commanding officer, capable of acting as his agent in harmonizing the plans, duties, and operations of all elements of the command. He should be familiar with the policies of the commanding officer and possess a thorough knowledge of organization, operations, administration, and staff techniques.

3. In order that the commander can make the best estimates and decisions concerning any given situations or problems, all staff officers must furnish him with the most accurate information it is possible to obtain and be completely objective in any advice they are called upon to offer.

The Staff's Job

4. It is the job of the staff to secure such information and supply such estimates and advice as the commander may require, preparing the details of his plans and translating his decisions and plans into orders which they in turn cause to be transmitted to the troops. They should keep the commander informed on all matters requiring his action or about which he should know, making continuous studies of the situation, and prepare tentative plans for any possible future contingencies for the commander's consideration.

5. It is also the job of the staff to assist the commander in coördinating the efforts of the command, and, in so far as authorized, so to supervise the execution of plans and orders as to carry out the commander's intent in accordance with established policies. In cases for which no policy has been established, action should be initiated to secure a policy determination.

Though thorough and complete, this abstract approach needs much amplification when a specific officer is assigned a specific staff position. The philosophy of the field officer assigned to staff duties for the first time needs to be revamped radically if he is to perform successfully.

Relationship to Intangibles

The basic ingredient of successful staff work is the ability to accept a close and constant relationship to intangibles. The Army normally deals physically with the products with which it is most concerned, whether it be men or materials.

The company commander may call a roster of names and have appear before him individuals to whom he can communicate an order, check the progress of the project which he has initiated, and finally judge the end product against defined standards. The shop officer can move through his shop and see the progress being made at the forge, the welding booth, and the lathe. He can observe, test, and inspect the final product.

Lieutenant Schroder is chief of the Plans Branch of the Ordnance Training Command, Aberdeen Proving Ground, Md.

Different Situation

The staff officer is faced with a situation much different. He deals normally with concepts, words, and statistics and seldom, if ever, sees the results of his planning activity. Where the line officer and operating officer can accept no compromise but must, despite all opposition or obstacles, achieve a clearly defined goal, the staff officer must frequently arbitrate conflicting views and effect compromise not entirely acceptable to any given element but conducive to the greatest end good.

Consequently the officer who is taken from a field operation and placed in a staff position must first of all adjust himself to, superficially at least, a less rewarding occupation and gain his solace from painstaking effort in the achievement of a product less solid than a 155-mm. howitzer—but perhaps as equally or more important.

Integrity

Perhaps the most important element which must be brought to bear upon staff work is integrity. It is sad but true that many field officers who epitomize integrity in their operations in the field unknowingly and unwillingly do not exercise the same impeccable integrity when once seated behind a desk.

In explanation of what would seem to be an unfair indictment, it must be stated that most violations of this doctrine stem from a lack of sympathetic understanding of the job. Frustration over a project long undertaken and seemingly no nearer to completion is finally dispelled with the first solution that appears to be, at least on the surface, logical.

No field commander would think of abandoning an objective merely because its accomplishment must be through encirclement and envelopment rather than direct frontal attack. Yet many staff officers become discouraged at the seemingly endless review and coördination, finally succumbing to the overwhelming desire to get a study out regardless of whether it represents the best possible solution.

Work Never Begun

Much staff work is stillborn primarily because it has never been started. Many staff officers at the beginning of a tour of duty plan a series of worthy projects, the magnitude and complexities of which build up in their mind to a point where the idea never reaches paper. The only solution is to start the project without inspiration and hope for the best rather than waiting for the inspiration before starting the project.

Many staff officers labor long and mightily and bring forth mice, but this is as much a part of the game as is the endless repetitive physical training exercises in preparation for a distant future combat operation. The salvation of these projects which never culminate in a finished product is that no work so accomplished is ever lost, as the residual value from an abortive effort is always brought to bear, albeit subconsciously, on similar projects in the future.

A basic tenet in combat holds that no commander assigns a mission to one of his subordinates that he is not prepared to undertake himself no matter how difficult or dangerous. This concept is equally valid in staff work and is probably violated more frequently than any other individual dogma. There have been many more instances of second lieutenants laboring over staff projects which should be in the hands of field-grade officers than there have been occasions of second lieutenants commanding battalions.

Kinship Lost

There is a dangerous prevalence of opinion among staff officers that when once so assigned their hours become nine to five, Monday through Friday. The same officer who prides himself that whenever his men are on duty he is also present, eventually loses the same spirit of kindredship with clerks, typists, and stenographers, whether military or civilian.

The staff officer who loses sight of this important factor soon loses the respect of his personnel, and although the end result is not as disastrous as it would be in battle, the operation of his activity will be considerably lessened in its efficiency.

There seems to be a distinct opinion among military personnel that the English language, like Sanskrit, is not here to stay, and consequently there is no need to concern oneself with learning the subject. More brilliant and valuable ideas have been submerged and lost in the unintelligible jargon of sloppy, careless writing than have ever seen the light of day.

The staff officer who cannot properly, clearly, and concisely present the problem and its solution had best request reassignment to a position where he can demonstrate physically what he is unable to say.

Time and Money Wasted

Much time and money have been spent in the average staff office through the employment of administrative assistants, secretaries, and various other categories of personnel whose sole purpose in life is to bring order out of the chaotic mumbo jumbo that flows in unbroken stream from many otherwise effective operators.

A staff officer owes it to himself and to his commanding officer to present a document that does not have to run the gamut of editors and administrative assistants. If the solution presented is the one that an officer believes is proper, he should not jeopardize its acceptance through a shoddy manner of presentation.

The niceties and explicitness of expression in staff studies may be the window dressing or icing on the cake, but just as these qualifications sell goods commercially, so does the clearly prepared document sell the idea to the commander.

The staff officer who can bring to bear on any given problem an incisive, alert mind is valuable indeed. This will be particularly evident in any gathering where there are more than two people. An organization owes a great debt to the man who can cut through the superfluous and idle chatter that normally surrounds most conferences to the heart of the problem. The psychological approach to a conference should be one of experiencing the feeling of a hot knife which is going to be exposed to a tremendous amount of cheese that needs slicing through.

End Objective

The end objective of every staff officer attending a conference should be to go in one door and out the other, leaving behind him a few well-chosen phrases, his position and recommendations on the problem at hand. Sad but true, many conferences degenerate into the male equivalent of the ladies' sewing bee, and with proper application practically any given one could be reduced in time by approximately fifty per cent.

A conference is not the American counterpart of the Mexican siesta, but should supposedly bring divergent opinions and recommendations to bear on a difficult problem.

There is an inherent danger of becoming deskbound in every staff position. There are more so called coördinators of matters that have not been seen by the coördinators than there are illogically prepared staff studies—but not many more.

Contrary to popular belief, staff offices do not come equipped with shackles which are locked upon arrival in the morning and unlocked in the evening. There is no objection to the staff officer inspecting operations upon which he will be expected to pass judgment.

There is no more futile feeling than for an organization in the field to receive a directive for implementation, the first paragraph of which indicates that the preparing officer has not the slightest concept of the capabilities and mission of the unit affected. A staff officer owes it to himself, his commanding officer, and the people in the area he serves to know as much or more about the subject than the people he directs.

No Magic Solution

This matter of staff work is not a sacrosanct theory that should be viewed with foreboding and fear. It requires adjustment in philosophy and, of course, the desire and willingness to serve effectively. There is no magic solution, just as there is no panacea for operational problems in the field.

Amplex

Technician, above, compacts 105-mm. rotating-band blanks from iron powder.

Powder Metallurgy for Better Ordnance

Recently Developed Process Creates Greater Firepower at Lower Cost

Capt. John D. Dale

Frankford Arsenal, Philadelphia

A HANDFUL of men in Ordnance and industry have seen the application of powder metallurgy in the national defense grow from almost literally zero to such a vast utilization that its details would fill volumes. This development is a long and fascinating story full of thrilling episodes, sensational results, and remarkable achievements. There were failures, misconceptions, and disappointments, too.

Early Pioneers

Around 1910, Coolidge of the General Electric Company first discussed his process for the manufacture of tungsten wire directly from the trioxide of tungsten without first melting the metal. This development fired the imagination of other men now recognized as pioneers in powder metallurgy, such as the late Charles Hardy, Dr. E. J. Hall, Albert J. Lent, Dr. Carl Claus, and a host of others who demonstrated that many different metals in powder form could be manipulated much more accurately and quickly than the classic methods.

Men like A. J. Langhammer, R. P. Koehring, E. R. Darby, Dr. Paul Schwarzkopf, James H. Davis, Prof. John Wulff, Prof. Gregory Comstock, F. C. Kelley, and Dr. Richard Kieffer gave great emphasis to early applications in the automotive, electrical, radio, and allied industries.

Art to Science

In the early 1930's a growing list of younger men began to devote their careers to the new art, and by 1940 the industry had begun to assume well-defined lines of interest and fields of application. The art was then rapidly becoming a science.

Ordnance officers and Ordnance civilian engineers had been watching the developments in powder metallurgy since World War I and were responsible for the application to ordnance of large quantities of tungsten-carbide tools, self-lubricating bearings, and electrical contact materials which have become commonplace and are no longer thought of especially as having been manufactured from metal powders or by the powder-metallurgy technique.

When materials and tool capacity both became critical for the manufacture of 20-mm. rotating bands in World War II, Col. John H. Frye and E. H. Engelke of Army Ordnance called in Mr. Langhammer of the Chrysler Corporation, who with the late Mr. Hardy had developed the first sintered metal rotating band.

Within two weeks the first sintered copper bands were delivered to the Ordnance Department for a test which demonstrated the acceptability of sintered bands. Red tape was slashed. The Amplex Division of Chrysler went into production within days thereafter and produced many millions of 20-mm. copper rotating bands at a lower price and to a greater precision than conventional bands cut from tubing.

Many Applications

There were a great many other applications during World War II, many of

which did not come to light until the end of the war when security restrictions were lifted. Apart from the tons of bronze, copper, and iron consumed for bearings, bushings, filters, and machine parts of all descriptions, there were exciting new applications in the fields of electricity, electronics, refractory metals, permanent magnets, and automotive strip bearings. Out of the war in Germany came the story of the German manufacture of sintered iron rotating bands where iron powder had been used because of the extreme shortage both of wrought copper and copper powder.

Rapid Growth

By 1945 the metal-powder industry had enjoyed a rapid growth but was prepared to cut back for conversion to the civilian economy again. This cutback lasted only a very short time. The industry had taken a permanent step forward both in volume and in knowledge. Ordnance had profited by the opportunity to apply this metalworking technique on a very large scale, and the time for evaluation had arrived.

In Washington and at the Frankford and Watertown Arsenals career Ordnance engineers were given the task of evaluation at the same time that teams of specialists were sent to Europe to review the experience of the enemy, following his defeat.

As partial industrial mobilization got under way in 1950, Ordnance looked again to powder metallurgy. The Chief of Ordnance has since waged such a relentless attack on materials, methods, and costs that there are well over one hundred new components on which development work has been started.

Money Saved

Of these items, several are already in production. A small fuze component, which has been in production since May 1951, has already saved the taxpayer over two million dollars. Others, on which development engineering is almost complete and which will probably reach production before the end of this year, are estimated to save the taxpayer an additional ten million dollars.

If wide use of sintered iron rotating bands (beyond those already in production) and certain types of small-arms ammunition should be found feasible, the estimated additional annual saving would be eight million dollars.

Applied research on sintered iron rotating bands began toward the end of World War II. There were other interesting ferrous band materials investigated, and some are still under serious study. By the end of 1950 the sintered-iron program had reached such a point that specifications were written for rotating bands on high-velocity artillery projectiles (MIL-R-11073A).

The shortage of copper required immediate conservation measures and indicated the wisdom of considering the application of sintered iron rotating bands to other types of artillery ammunition, especially for such large-volume types as the 105-mm. shell where a substitution would produce impressive savings.

Product engineering having been carried to a point where it was ready for production engineering, the Industrial Division, Office, Chief of Army Ordnance, was assigned responsibility and placed the project at the Frankford Arsenal late in 1950.

Optimism Premature

The job to be done first was thought to be primarily production engineering, but it was quickly evident that development work had not been carried to the point where such important matters as surface preservation and individual shell design had been seriously considered. The optimism which prevailed in industry for early production of sintered iron rotating bands was premature.

An appraisal of the situation led Col. Ward E. Becker, commanding officer of Frankford Arsenal, to take steps to unify the program. The result was appointment by the Chief of Ordnance of the Sintered Iron Rotating Band Coördinating Group, which consists of technical representatives of the Frankford, Picatinny, and Watertown Arsenals with the author as chairman.

The Coördinating Group has worked most effectively with the American Ordnance Association Committee on Powder Metallurgy, and the results are another outstanding example of Ordnance-Industry coöperation.

In an early test to evaluate suitability of different types of commercial iron powders, Ordnance personnel, then unskilled in some of the finer points of powder metallurgy, did not know that iron powders produced by different methods respond differently to uniform sintering conditions, even when pressed to the same density.

Some adjustments in pressure had been necessary in order to produce the established density of 5.5, but when some types of powders fell below the required minimum tensile strength and elongation specifications it was erroneously assumed that these powders would not be suitable for rotating-band production.

Problem Eliminated

Some powders used alone may not be suitable, but others can be used by blending, by preliminary reduction and annealing treatment, or by a longer sintering time at temperature. In any case a tremendous increase in production capacity during 1951 for suitable types of iron powder has eliminated this as a problem.

Production methods and the assembly of other metal parts of the shell introduced process limitations in the shell shop, so that a series of studies had to be made. The influence of a change in the surface-preservation materials on the band-impregnating material, on the iron itself in the method of applying the preservative, and on the resulting ballistic performance of each individual type of ammunition is now known.

One critical variable was found to be the type of impregnating material used and the influence it exerted as a corrosion inhibitor on shell-banding methods, on ballistics, and on the rate of erosion of the gun.

It was necessary constantly to remind all those connected with the program of the purpose of a rotating band. The rotating band is only one element which goes to make up a shell or projectile, and a projectile has only one purpose for its existence—to cause the maximum possible damage to the enemy. It is actually rather difficult to recognize the rotating band on the shell, ready for firing, as the same object which is seen coming out of the cooling zone of a sintering furnace.

Severe Treatment

Long before the projectile reaches the target, its rotating band has to be submitted to severe compression in

order to swage the band blank into the band seat. It is then machined to final profile, and the complete assembly is put through seven steps of cleaning and zinc phosphating prior to painting or finishing.

The most devastating treatment of all which the sintered iron rotating band must support is during the firing of the projectile. In a matter of microseconds the band is submitted to extreme forces of triaxial compression with massive plastic deformation, then high hoop stresses instantly follow as the projectile leaves the muzzle of the gun.

Density Increased

When the rotating band leaves the muzzle its density has increased in some cases by as much as forty per cent, its ductility is reduced to less than one per cent elongation, and the metal has been upset by nearly eighty per cent in two successive stages.

It was not easy to explain to the metal-powder fabricator exactly what was wanted in the band blank, with so many apparently inconsistent requirements, so that the band would survive as a solid piece of metal until the projectile hit its target. The 105-mm. howitzer, in particular, is a precision weapon. The rotating band, which has such a strong influence on the accuracy of a round, cannot be permitted to cause a wide dispersion. Each round, including the first one, must hit its target.

Knowing perfectly well that one of the advantages of powder metallurgy is uniformity, it was hard to explain why early firing results were so erratic. This was finally attributed to the combination of destructive forces applied after the band blank was made.

Blanks Processed

The rotating-band blank, as delivered by the fabricator, had to be so processed as to permit subsequent deformation and severe treatment without a completely destructive influence on the metal at any stage. Early firing tests revealed that when a band on the shell ready for firing had a minimum tensile strength of 10,000 psi, with a minimum elongation of 2 per cent, the rotating band would at least perform its function and stay on the shell during flight. Bands of lower physical values failed.

However, it was observed that band blanks which met these physical requirements often lost seventy-five per cent of the tensile strength during the banding operation. This distressing situation was cause for extensive experiments, and it was found that the porous metal matrix had been compressed beyond its capacity at localized overstressed areas.

There was no comparable situation in the field of bearing manufacture where the nondestructive pressures and velocities are a fraction of those imposed on the rotating band.

Metallographic examination revealed that the rotating-band blanks could be banded successfully without loss of tensile strength if the band blank had been so very thoroughly sintered as to cause the original particle boundaries to disappear. This depended largely upon sintering time and temperature and on the "sinterability" of each kind of iron powder.

It should have been clear that structural strength could not be expected in a metal whose structure had never been formed. To assure this structure, complete recrystallization across the original particle boundaries is necessary.

Choice of Material

Except for rather broad specification limits, the choice of raw material and the method of fabrication are left entirely up to the fabricator. Shell performance, therefore, depends as much upon the fabricator's ability to make a structurally sound band as on careful attention to details in the shell manufacturing shop methods.

The established policy has been to get the sintered iron rotating bands into limited production as soon as safety and common sense will permit. This band costs one-third less than the corresponding gilding-metal band, but it was not until very recently that the first large quantities of shell could actually be released for production.

The bands now in production are not the best that can be developed. But the avenues for improvement are well defined, and the coördinated efforts of the three arsenals with the capable advice and assistance of the American Ordnance Association Committee on Powder Metallurgy are expected to produce the desired improvements and further applications of sintered iron.

In the manufacture of fuze components, Army Ordnance has found probably the most lucrative place for saving money and materials. Although the Industrial Division of the Office, Chief of Ordnance, investigated the possibility of manfucturing fuze components by powder metallurgy during World War II and arrived at the point where limited specifications were written, the end of the war made it unnecessary to expedite further substitute materials and methods.

Situation Different

Also, the metal powder industry at that time was not able to offer real savings in terms of money. The situation is different now. The story of the M21A4 booster rotor made from sintered brass powder appears in the March-April 1952 issue of ORDNANCE (Volume XXXVI, No. 191).

This rotor was originally authorized for production by powder metallurgy in brass; but having been successfully produced since then from copper powder by the United States Graphite Company, a general alternate approval has been given for sintered copper.

Since April 1951, the Frankford and Picatinny Arsenals, which have been assigned technical responsibility for fuzes by the Chief of Ordnance, have a long list of similar components under study and development.

Production of fuzes is ordinarily so large that even though one of the components costs only a few cents, the saving to the American taxpayer is expressed in terms of hundreds of thousands of dollars.

Teamwork

The reason for the success in applying powder metallurgy to fuze components is teamwork. Men of Ordnance and industry, each expert in his particular field, under the vigorous direction of the Chief of Ordnance have begun to record an achievement which history may prove to be perhaps one of the less glamorous but one of the all-time important basic achievements of Ordnance.

Small-arms ammunition is another field in which hundreds of millions of precisely shaped metal pieces are required. By definition alone, it can be assumed that powder metallurgy will find a vast application in this field. But

high-speed, conventional metalworking techniques, utilizing metals of very high physical properties, are so well established that except for some rather unusual applications there is no immediately compelling reason for a general conversion to powder metallurgy.

German Ammunition

During World War II, hundreds of millions of rounds of small-arms ammunition were manufactured in Germany from iron and steel powders, as well as from the better-known tungsten carbide. This was a vastly important conservation measure where lead was in critical supply.

German small-arms experts have observed that sintered iron and steel gave the German Army short-range firepower with a capacity to kill that was second to none. It is, therefore, in the national interest to consider sintered iron small-arms projectiles as a new class of ammunition rather than as a direct substitute on a performance basis for present types.

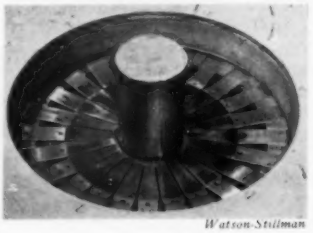
Along this line of thought Frankford Arsenal has developed, in collaboration with a leading industrial powder-metallurgy organization, a 20-mm. practice projectile pressed entirely from iron powder, whose performance in several preliminary tests has indicated the practicability of this useful round.

A large-scale firing test to be conducted soon will reveal any further improvements which may have to be made. If successful, it will provide a saving of at least twenty cents on every round of 20-mm. practice ammunition fired from now on by the entire military establishment.

Sintered Iron

Experiments under way with sintered iron ball ammunition also may make possible the elimination of nonferrous metal jackets, which have been used heretofore to prolong the life of small-arms weapons and to protect the ammunition from oxidation and corrosion.

Cartridge cases for small-arms ammunition have been manufactured of steel for some time and in enormous quantities. This is also true of shell cases for artillery ammunition. But the raw material from which these cases are successively stamped and drawn has inherent defect potentials which make its manufacture difficult to control and



Technician places simulated shell into 24-jaw hydraulic banding press, above. Below, after slack take-up, same press prepares to seat the rotating band.

Watson-Stillman

the available supply of the optimum quality very small indeed.

Positive Control

With the purest kinds of iron powder available in large quantities at low cost and with the possibility for controlling the sintered compact in so many ways, it is entirely possible to produce the exact composition of metal, the exact grain size and grain structure and with a minimum of impurities which are so widely distributed throughout the mass of metal that they are not detrimental anyway.

The first experimental cartridge cases produced from sintered iron cups have already been produced. Only the mechanics of the operation have been worked out, and much remains to be done.

Economically, the important observation is that the iron ore is reduced directly to powder, the powder is pressed directly into a deep cup and is never melted, all of the rolling mill operations are eliminated, there is no scrap loss whatsoever, and all five manufacturing steps in the cartridge-case plant which lead up to the manufacture of the cup are discontinued.

Whether this technique will find application in cartridge cases or shell cases larger than 20-mm. is not known, but if it should only apply to small-arms ammunition there will still be a tremendous saving in materials, manpower, and time with an improved quality of the end product.

Recent Developments

The Ordnance Corps is aware of the most recent developments in the powder metallurgy of alloy steels including stainless steels. There has been a wide use of self-lubricating bronze bearings for over twenty-five years. This type of bearing can only be produced by powder metallurgy.

But now self-lubricating bearings are available in stainless steel of three different alloys; they are available in the same stock sizes as the conventional bronze bushings, bearings, and plate materials, and they solve a performance problem which has long plagued many a designer both in industry and Ordnance.

Ordnance also knows that stainless-steel parts with a controlled porosity are available with pore openings from 0.5 microns to approximately 40.0 microns. Aside from its utilization for laboratory-type filters in corrosive media, its potential for use in automotive and aircraft fuel-line filters where high physical strength is also required is obvious.

Startling Results

There have been many projects studied in which powder metallurgy was found to offer either no advantages or where the technique would be a foolish application. Powder metallurgy will not displace other established ways of working metals. Its advantages in some cases are hardly more noticeable than offering vastly increased production facilities. But where it has been applied the results have been startling and the advantages great.

Ordnance can point with pardonable pride to its achievements in the application of powder metallurgy. This is only another example of the way Ordnance research is made to pay off. It is another way in which American Ordnance continues to produce greater firepower and better fighting equipment for the armed forces.

The American citizen-taxpayer can find comfort in the greater security and the tremendous monetary savings which are being created through powder metallurgy.

Table of 42-ft. boring mill is centered on TIMKEN® bearings; runs true within .001"

THIS giant Consolidated vertical boring and turning mill is one of the world's largest. Its 20-foot table weighs 60 tons—can take a work piece up to 42 feet in diameter weighing 82 tons! Its table runs true within one thousandth of an inch!

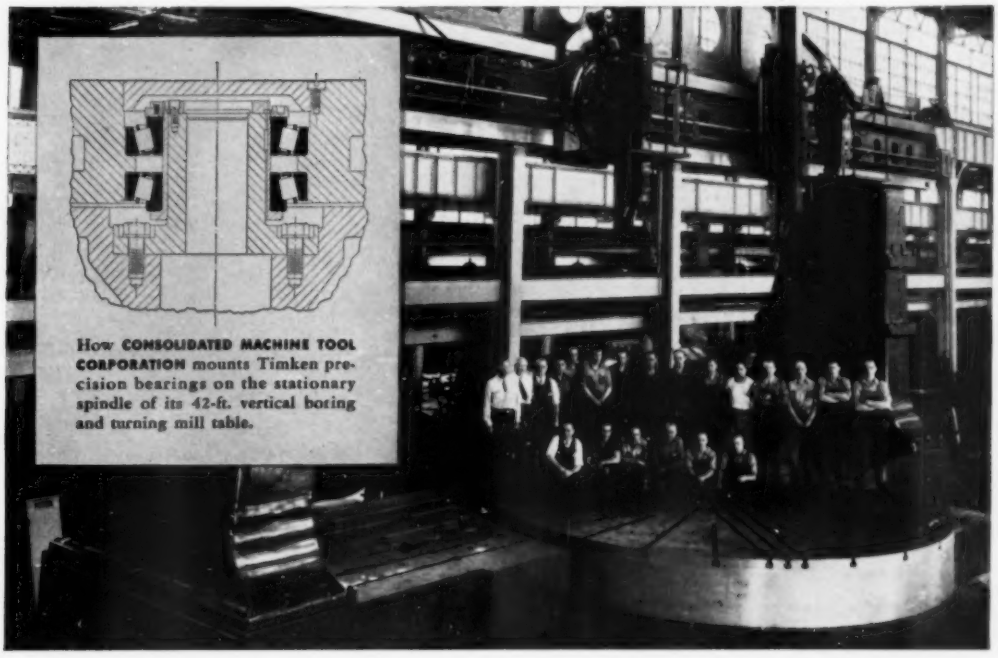
To make this amazing precision possible, Consolidated uses Timken® tapered roller bearings on the table centering spindle. These precision Timken bearings have high load carrying capacity resulting from line contact between rollers and races. Their tapered construction permits preloading. The result: deflection is minimized, long lasting accuracy is assured.

To help turn the total 142-ton load smoothly, Timken bearings are also used in the drive. They hold shafts in alignment, insuring accurate gear mesh, longer gear life.

Due to the ease with which Timken bearings can be set up, manufacturing costs are reduced. Auxiliary thrust bearings are eliminated, table maintenance is simplified.

No other bearing can offer you all the advantages of Timken bearings. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How **CONSOLIDATED MACHINE TOOL CORPORATION** mounts Timken precision bearings on the stationary spindle of its 42-ft. vertical boring and turning mill table.

FINISHED TO CLOSER TOLERANCES

Finishing to incredible smoothness accounts for much of the precise, smooth rolling performance of Timken bearings. This honing operation is typical of the amazingly accurate manufacturing methods at the Timken Company.

The Timken Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⓘ AND THRUST →ⓘ← LOADS OR ANY COMBINATION →✳←

Make things gloomy for Canis Nimbulus

Canis Nimbulus (gloomy or unhappy dog) is the stalking timber wolf that roams the forests of our western states. This vicious predator is aptly named, for it vents its gloomy rage on weaker neighbors.

One timber wolf can swiftly kill a sizable flock of sheep. And when these wanton murderers foray in groups, they pull down deer, moose and wounded animals of all sizes. *Canis Nimbulus* is a real peril to man and beast.

You'll enjoy giving the timber wolf a gloomy time of it. Whenever this marauder crosses your path, shoot on sight. Remember, however, that conservation authorities favor the control, not the extermination of the timber wolf. He does help preserve the balance of nature by killing off weak and crippled animals. So check local regulations before killing off the timber wolf.

Besides controlling predators like the timber wolf, today's good sportsmen can help preserve our country's game by actively working in local and national conservation programs.

N.R.A. RANGER

Write for free booklet on how to start a rifle club . . . win Ranger Shooting Emblems. Sportsmen's Service Bureau, Department D-6, Sporting Arms and Ammunition Institute, 343 Lexington Ave., New York 16, N. Y.

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150th Anniversary

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DU PONT SPORTING POWDERS

WORLD-FAMOUS SINCE 1802